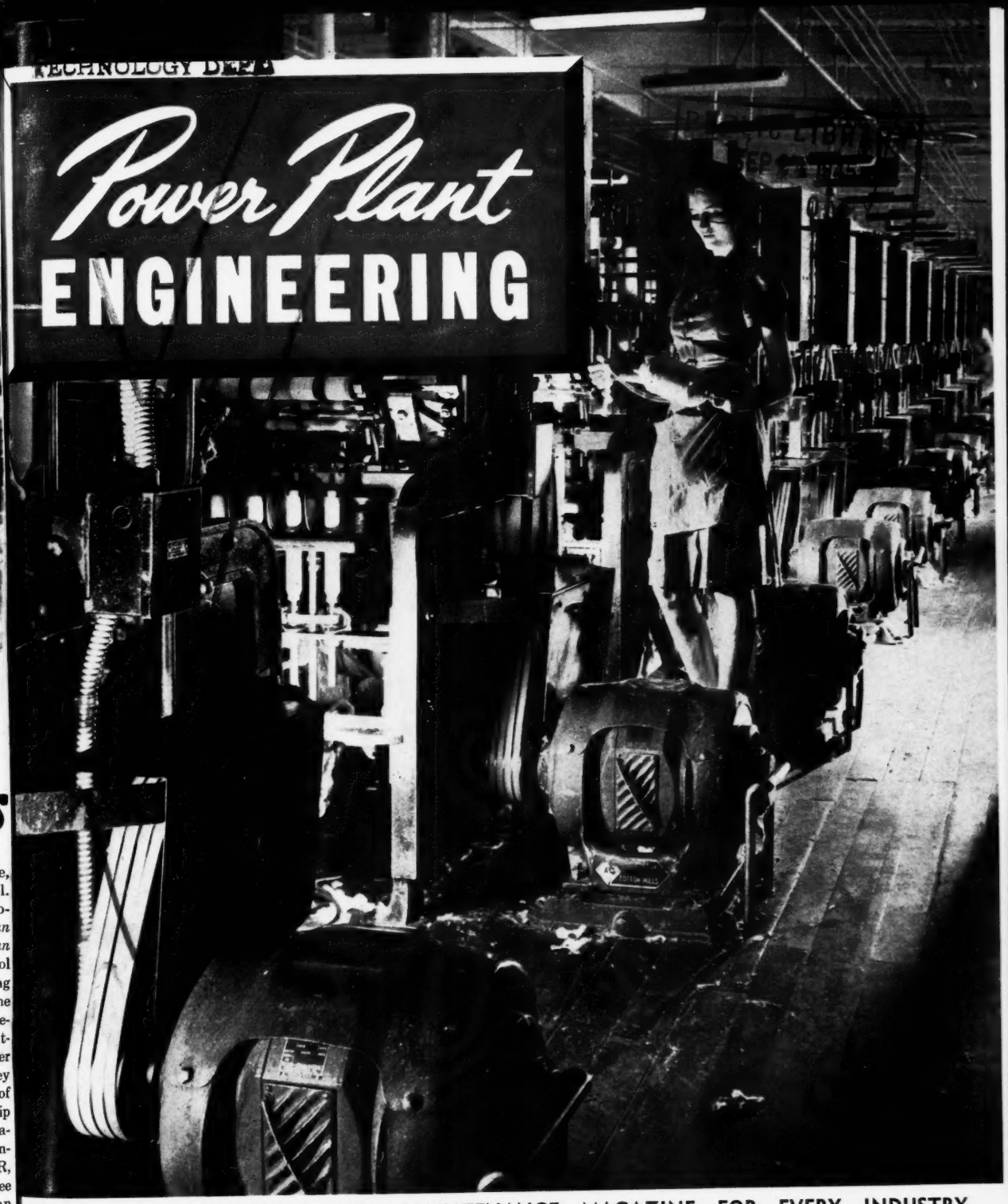
TECHNOLOGY DEPT.

Power Plant ENGINEERING

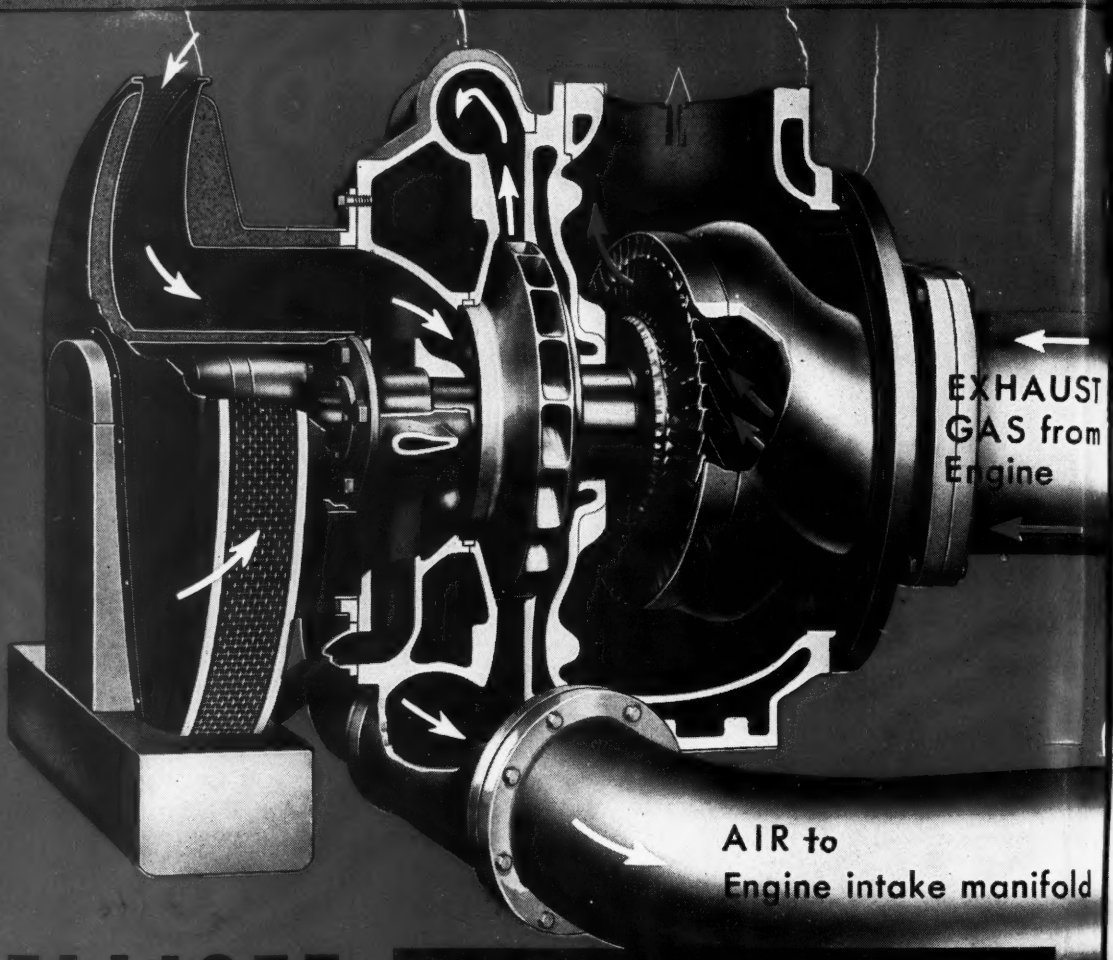


THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

SEPTEMBER • 1945

Features

ATOMIC ENERGY IS HERE · URANIUM AND ATOMIC ENERGY · ATOMIC BOMBS AND THE FUTURE · NEW POWER PLANT FOR STANDARD'S BATON ROUGE REFINERY · POWER NEEDS FOR POSTWAR MANUFACTURES · · · CONTENTS PAGE 5



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M-78

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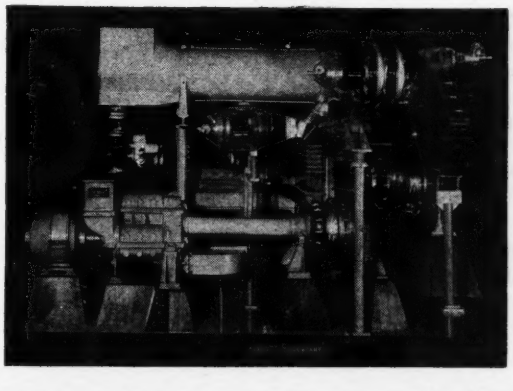
The Elliott-Buchi Turbocharger is an outstanding success. Almost every 4-cycle Diesel manufacturer now turbocharges, and turbocharged Diesels are fast becoming too common to excite comment. Their increased power, improved operation, and reliability are being taken as an accepted fact.

To bring the turbocharger to this successful stage was a considerable triumph for Elliott engineering. It necessitated the solution of many difficult engineering problems, such as proper turbine design for 1000°F operating temperature at high speeds, sealing hot gases, lubrication and cooling of shaft, wide spread of temperature between turbine and blower. The turbocharger must also be engineered to the individual engine. A big problem was metallurgy, and Elliott engineers have succeeded in building a unit to operate continuously throughout the life of the Diesel it serves.

Using the experience gained in the successful design of the gas-driven turbocharger, Elliott engineers have advanced the next step, to the successful design of the Elliott Gas Turbine—prime mover of the future. Complete information on this important development will be given at an early date.



Model of Elliott 2500-hp gas turbine. Actual unit is operating on test in our Jeannette plant.

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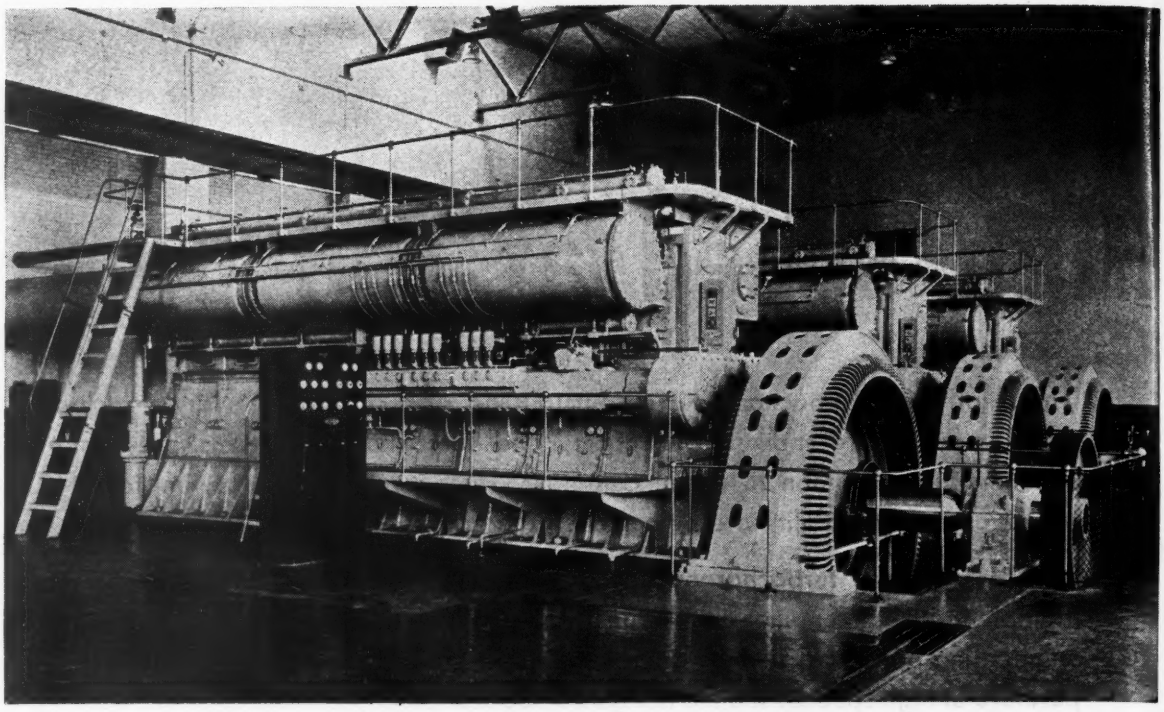

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Use the oils that . . .

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Texaco Ursa Oils are typical examples of petroleum products improved through The Texas Company's constant research. Their production is 100% Texaco controlled from well to finished product. Crudes, carefully selected for their ability to assure efficient and economical Diesel operation, are processed by modern Texaco methods in a most efficiently equipped, up-to-the-minute refinery . . . and absolute uniformity is assured by the constant supervision of an army of skilled and experienced technicians.

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Power Plant ENGINEERING

September 1945

VOLUME 49—NUMBER 9

Cover: Special lint-protected motors and V-belt power drives help textile mills meet heavy production schedules for clothing and fabrics. Photo, Allis-Chalmers.

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PIONEERING *in the early* 20's

Do you remember the early 1920's, when many of us sat up half the night with our ears pinned down and numbed by a radio headset, while we tickled the cats-whisker of our crystal radio set hoping to get some distant (or even nearby) station. Radio has made great progress since those early pioneering days . . . and this progress has been paralleled by improvement in ash and dust handling methods, pioneered-developed-patented-installed and operated by our company over this same span of years.

Back in the early 20's, our company was confident that dirt, dust, fumes, falling water, and fog could be eliminated from the unhealthy ash tunnel. Time has proved we were right. The ash tunnel has long been an ash basement, as clean and dry as the turbine room.

First came the perfection of a Water Collecting Ash Gate, known as the "Type C", closely followed by the A-S-H Sectional Cast Iron Plate Ash Hopper. Locktile, a refractory shape, gravity locked in place for lining these hoppers, followed, together with A-S-H quenching units used to distribute a uniform spray over the entire ash accumulation.

Next came the Cast Iron, Sectional Plate, Catenary Coal Bunker, which "breathes" under load.

Then, with the trend toward larger units differently fired, came the development of the Hydrojet System, an air-tight, water-tight, dust-tight system which quickly, automatically and economically removes large ash tonnages rapidly and with no manual effort.

Next came the Hydrovac System for removing dust from various pockets throughout the plant, with the Hydrovactor unit, windsweeping principles, etc.

The Hydroseal Pump with the principle that revolutionized the design of materials handling pumps; Dehydrating sumps and tanks with anti-freeze water collecting gates embodying dehydrating principles; continuous dust unloaders and the Mylting Mixer all followed in order.

These are the major products pioneered, developed and "made to work" by our engineers. Their perfection did not come easy. There were many disappointments and heartaches. The development of each product required many new inventions to contribute to its ultimate success. But that is another story. We believe you'll be interested, so we're going to follow this advertisement with others, which will outline the step-by-step development of each.

And now for the $25.00. Simply because we have no illustration to show our early hoppers and gates, we're asking you to look in your files for a catalog referring to these products as being "Built Like a Battleship." We'll pay $25.00 for the first ten of these catalogs sent to this office and we'll acknowledge receipt of those from whom they were received in a later advertisement.

AS ALWAYS (A-S-H) WILL PIONEER IN ASH AND DUST REMOVAL

ALLEN-SHERMAN-HOFF CO., 227 S. 15th St., PHILADELPHIA 2, PA. *Offices & Representatives in Principal Cities*

Front Lines

HOW TO PROTECT Your War Bond Investment, the title of a very interesting booklet being issued by Commodity Research Bureau, Inc., should be of direct concern to everyone who has put his money into war bonds. One of the ways to protect this investment is to do everything possible to prevent some of the nation-wide swindles that may be attempted after this war just as they were after the first World War, when swindlers took hundreds of millions of dollars from Liberty Bond holders. There is considerable evidence that many such schemes are being tried in an attempt to secure some of the money now being paid to veterans and that other schemes will be tried as time goes on. A concerted effort is being made by the National Better Business Bureau, Securities and Exchange Commission, a great many industrial companies, and other organizations to warn the public against the schemes they will encounter for acquiring some of this hard-earned war bond money without doing any work. These run the gamut of antique swindles, fake diamond appraisers, fake radio auditions, illegitimate solicitation for illegitimate charity schemes, payments for non-existent foreign jobs, and, of course, the old familiar rackets involving fur farms, non-existent oil wells, perpetual motion patents, and the like. A booklet discussing the situation in detail, telling what to look out for and giving many interesting details about the value of war bonds and how they are protected under the law, has been published by Commodity Research Bureau, Inc. If you're interested, write to us for a free copy of the booklet.

ELIMINATION of the costly spinning and weaving operation in fabric production has long been desired by textile producers. It has not yet been achieved so far as apparel fabrics are concerned but unwoven fabrics for specialty applications are being used increasingly. Cotton, the principal fiber used in making the unwoven fabrics now in production, is cleaned, picked and carded as in conventional textile operations. At this stage it may be treated in any of several ways to produce the unwoven fabric, says the Industrial Bulletin of Arthur D. Little, Inc. Masslinn, an adhesive-bonded fabric, is one form, Webril, made by blending heat-softening fibers into the cotton web, is a second form; and there is a third type in which the fibers are bonded together by the action of a chemical solution.

SANTOCEL, a new insulating material discovered in 1931 by a U of I professor and claimed to have twice the efficiency of cork as an insulator of heat, will be produced in a new plant to be built for the purpose by Monsanto Chemical Co. The material is a silica "aerogel" with a light, fluffy structure, a void space of about 94 per cent and very light weight. It has been incorporated in many items of war production and now some post-war products such as refrigerators are being designed to use it.

FOR TRANSFERRING ACIDS and other corrosive liquids safely, the Speare's Safety Siphon is now supplemented by the Speare's Safety Pump, both made of the same plastic material. The pump does not replace the self-priming siphon, for the latter is still recommended for transferring comparatively large volumes. Both pump and siphon operate without exerting pressure on the sidewalls of the glass carboy. The plastic construction of the pump is designed to provide excellent acid resistance qualities, safety in use and long life. It is of adequate size for carboys of 5 to 13 gal capacity. A plastic cord and noose is provided for quick installation, permitting the pump to be affixed securely to the neck of the carboy. The list price of it is given as $15.00.

STUDY OF THE GERMAN power systems by experts of the Office of War Utilities, begun last March, has begun to yield valuable information, although a great deal of it must still be withheld under security regulations. One report released is that high-voltage cable and air circuit breakers unfamiliar to us and found in the German systems are to be shipped to this country to be studied after installation on an American system. There were reports that the Germans were working on very high voltage transmission, both a-c and d-c, also on graphitization of high temperature steam piping alloys, very high pressure hydrogenation and similar problems. The OWU representatives are studying these and many other items disclosed by the search. The investigation of German power practices was begun in March under the direction of C. W. DeForest, engineering consultant in Cincinnati, formerly of Columbia Engineering Co., who went to London for that purpose.

FISH FENCES to prevent fish from destroying themselves in the intakes of irrigation projects, hydroelectric plants, and industrial plants are not made of barbed wire, but of devices that give the fish a mild and harmless electric shock as he approaches the screen and send him scurrying safely away from it. Rows of metal pipes or electrodes that swing freely from an overhead support are connected with an electronic generator developed jointly by the Electric Fish Screen Co. and Westinghouse. This generator produces impulses at from 4 to 8 per second using a special wave form that will turn back both large and small fish simultaneously, something that cannot be done with ordinary current. The electronic screens are also used to fence in the fish at hatcheries.

OUR GREATLY ENLARGED aluminum industry has devoted much thought to post-war products. Among those announced, is a thin, flexible, pure aluminum household foil. It will come in convenient packages to be torn off in any lengths desired. Foil wrapped foods keep longer because foil is solid metal and light cannot penetrate, it is moisture-proof, and odors cannot be taken on or imparted.—Ohmite News.

DEPARTMENT OF LIBERAL EDUCATION in the House Organs in 15 Minutes a Day *** Clean Up Air Conditioning Equipment Now—directions for cleaning filters, air washers, evaporative condensers, and other equipment; Oakite News Service, May-June, 1945 *** Fire Protection for Industrial Record Vaults, well illustrated with photographs of details showing how to protect original drawings, micro-copies or master prints of products, which are extremely valuable possessions of industrial firms; Kidde Industry, May, 1945 *** Business in Two War Periods, a detailed comparison in diagrams and tables of the changes in business between the periods, 1914-1923 and 1939-1945 by Leonard P. Ayres; The Cleveland Trust Company *** Gardens Without Soil, a detailed explanation of the principles and some of the very simple equipment that can be used for this new method of growing things; Compressed Air Magazine, June, 1945 *** Calling All Nations, well-illustrated story on FM radio, television and other miracles of modern communication; Shell Progress, May-June, 1945 *** Instant Start Fluorescent Lamps, describing how the circuit required differs from ordinary methods; Sylvania Lighting News, May-June, 1945 *** A Stadium with an Air-Supported Roof; English Tidal Power Scheme Revived, describing the plan proposed for the Severn River; Compressed Air Magazine, July, 1945

WHEN CEMENT is placed in water, many of the particles clump or flock together. Since tests have shown that the best results are gotten from cement only when each of the countless particles is wet all over, this tendency of the particles to bunch together greatly reduces their combined effectiveness or efficiency in concrete. Investigation has shown that the clumps are broken up when a small amount of calcium lignosulfonate, made from paper mill waste, is added. This product disperses the cement particles by electrostatic action. Tests have indicated that concrete produced with dispersed cement is stronger, less porous and lasts four to five times longer than when made with plain cement.

UP-TO-DATE INFORMATION on details of fuel burning is given in the new 1945 edition of the Manual of Instructions on Proper Firing Methods in the interest of fuel combustion and conservation, air pollution and smoke elimination, now available for 25 cents per copy at the office of the Smoke Prevention Association.

MOST MODERN TOWN in the West will rise in the shadow of Grand Coulee Dam in Eastern Washington after the war if plans discussed by the Bureau of Reclamation are fulfilled. From 450 to 500 new homes are needed for Government employees assigned to the Columbia Basin Project to replace temporary homes built during construction days. Designs for the new houses have been drawn at the Denver office of the Bureau. They have distinctive architectural features and would be of permanent construction: some of brick, others of wood or tile. Stores and other service establishments for residents would be built by private interests, operating under lease, and must conform with building codes and the general architectural theme of the community.

HELIUM IN TIRES of giant airliners instead of air will be used on a forthcoming plane of this type. It is claimed that helium, being an inert gas that has no known chemical affinity for natural or synthetic rubber, should provide longer tire life. Instead of 180 lb of air normally required for the job, only 26 lb of helium will be needed.

PUMPING OF OIL from England through pipe lines laid under the English Channel, to supply the Allied armies on the Normandy coast of France soon after they landed there, is one of the now-it-can-be-told engineering stories of this war. A system of 20 lines of 3-in. pipe, operating at 1200 psi pressure, has transported an average of 1,000,000 gal of oil a day across the Channel since June, 1944.

PLASTIC UPHOLSTERY for civilian use, which will provide designers and manufacturers with upholstery material that is both waterproof and flameproof, has been announced. Known as Naugahyde, it will be made in a wide range of light and bright, clear decorative colors and even two-tone effects as well as in a variety of grains.

WHAT MAY PROVE to be the largest iron ore discovery on this continent since the Lake Superior deposits is being explored in Labrador and eastern Quebec, says Business Week. Practically all the deposits are of Bessemer grade—low in phosphorus—and the iron-bearing belt is 40 to 50 miles wide and 350 miles long. Interested in the development is the M. A. Hanna Co., conservative developer of mining properties. Hanna's experts give odds that ore won't be mined in that area for some years to come but are interested in insuring future potential reserves.

RESEARCH at the laboratories of the Glycerine Producers' Association indicates that a glue-glycerine-water solution makes a good moistening material for filter bases such as are used in heating and air conditioning systems. A solution of 0.2 per cent glue in 50 per cent glycerine has been found satisfactory. When the filter becomes dirty or clogged, this mixture can easily be washed off the filter media with cold water it is claimed, and a fresh solution applied.

IF THIS COUNTRY wants "full employment," Dr. Roger J. Williams, director of the University of Texas' Clayton Biochemical Institute, declares that research can not only stand vast expansion to provide more research jobs, but creates new industries that will in themselves provide many jobs. "The problem of unemployment is not merely that of finding something for people to do—it is finding *profitable* and *useful* pursuits," he asserted in the current issue of *Science*.

GLISTENING ALUMINUM railings with self-contained "cold" lights will be installed atop Grand Coulee Dam when materials are available, symbolizing the role played by the dam in the light-metals industries of the Pacific Northwest.

WHY DO YOU FIND MAXIMS *on the really* TOUGH *silencing jobs?*

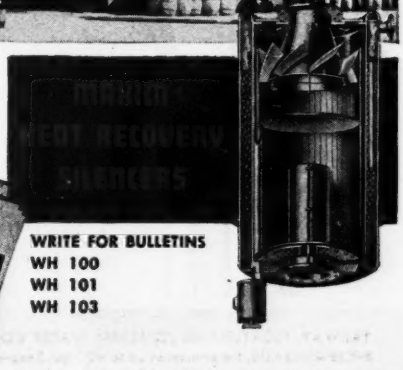
The giant Maxims standing out against the skyline below quiet the exhaust of Diesels on test stands at a large industrial Diesel manufacturing plant. Time and again in important installations of this kind and in many smaller installations where the silencing problem is none the less critical, the most satisfactory answer has been found with Maxims.

The reason "why" is threefold and lies in *experience, performance* and *adaptability.*

- Maxim can show more years of research and experience in solving tough silencing problems.
- Maxim performance over the years is typified in thousands of successful working installations, large and small.
- Maxim adaptability means a line of silencers so varied that it is seldom necessary to go beyond the standard silencers to get a job "tailor-made" for your installation.

By the same token when special silencers *are* needed, Maxim engineers, constantly working on development and new design problems, are particularly capable of solving your special problems.

WRITE FOR BULLETINS
D 125
D 127
D 101
D 37



WRITE FOR BULLETINS
WH 100
WH 101
WH 103

These Maxim Silencers (model MUC illustrated) are designed to silence the exhaust or intake of internal combustion engines, steam engine exhaust, air compressor intake, vacuum pump discharge and the intake or discharge of blowers of the positive pressure type. Wide choice of models to fit varying space and silencing requirements. Spark arresting where necessary.

Maxim Heat Recovery Silencers combine efficient silencing of engine exhaust with spark arresting (where necessary) and with the efficient recovery of waste exhaust heat to produce steam or hot water for heating or processing operations. These Heat Recovery Silencers give highly efficient heat transfer . . . are available with automatic controls, and may be run wet or dry without injury to the unit.

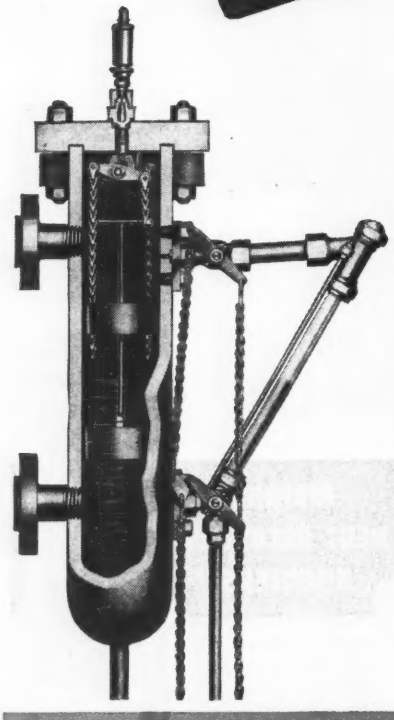
THE MAXIM SILENCER CO. • **89 HOMESTEAD AVE., HARTFORD, CONN.**

ARMY ★★ E ★★ NAVY

MAXIM

A YARWAY COMBINATION

Positive Boiler Water Level Protection



Why do so many power engineers insist on Yarway boiler trim? Because Yarway Water Columns and Gages, Remote Liquid Level Indicators and Yarway Blow-Off Valves give *positive* boiler protection.

Outstanding example is the Yarway Floatless Hi-Lo Alarm Water Column which provides instant warning by steam whistle of any dangerous deviation from normal boiler water level. Alarm mechanism employs *solid weights* which operate on the displacement principle . . . can *never* become waterlogged. Column is shown at left with Sesure Inclined round glass Gage for low and medium pressures. Column with Vertical flat-glass Gage for higher pressures is shown at right. Yarway Columns and Gages are fully described in Bulletin WG-1810.

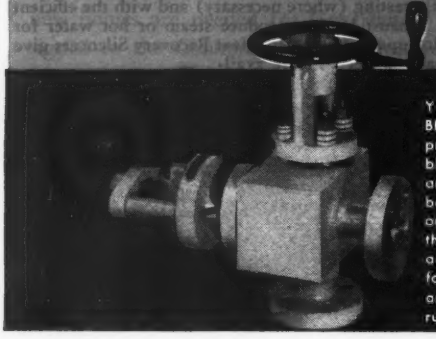
Investigate the complete Yarway line of boiler trim for your plant. It's a sound investment in boiler protection.

YARNALL-WARING COMPANY

114 Mermaid Avenue, Philadelphia 18, Pa.

Ask about the new Yarway 30-minute color and sound motion picture. with Lowell Thomas speaking—available for group showings.

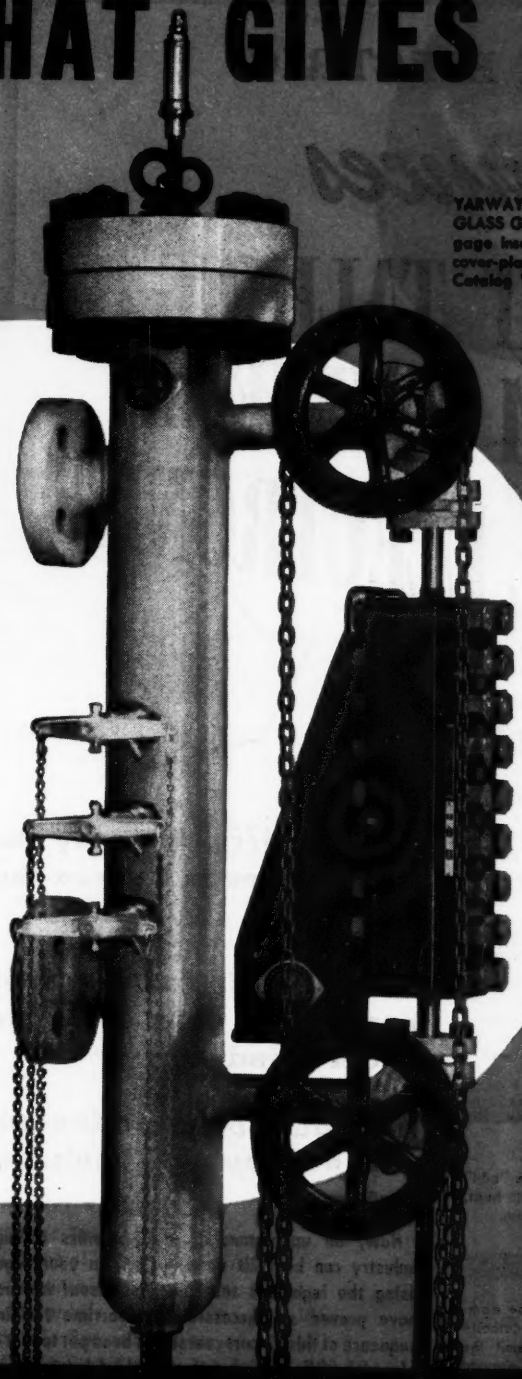
YARWAY FLOATLESS HI-LO ALARM WATER COLUMN AND SESURE INCLINED GAGE, for pressures up to 400 psi. Sesure Inclined Gage gives easier reading of water level from below. Ask for Catalog WG-1810.



YARWAY UNIT TANDEM BLOW-OFF VALVES, built for pressures up to 2500 psi. Combining a Seatless sealing valve and a Hard-Seat next-to-boiler blowing valve in a single one-piece forged steel body, this Tandem provides the advantages of both designs—for blowing or for draining and sealing—in a compact, rugged unit.

YARWAY SEATLESS TANDEM BLOW-OFF VALVES—standard in over 12,000 plants—for pressures to 600 psi. Famous balanced sliding plunger design with non-clogging, straight-through flow. No seats to score, wear and leak. Described in Catalog B-432.

THAT GIVES



YARWAY FLOATLESS HI-LO ALARM WATER COLUMN AND FLAT-GLASS GAGE, for pressures up to 1500 psi. Pressure-sealed flat-glass gage inserts are mica protected and have patented, spring-loaded cover-plates which prevent excessive strain on glass. Ask for Catalog WG-1810.

YARWAY REMOTE LIQUID LEVEL INDICATOR for pressures up to 1500 psi, brings boiler water level indication down to instrument panel or other convenient eye-level location—right in front of your eyes, on a brilliantly-lighted scale. Operated by the boiler water itself, using the pressure differential between a constant head of water and the varying head in the boiler drum. Ask for Catalog WG-1820.

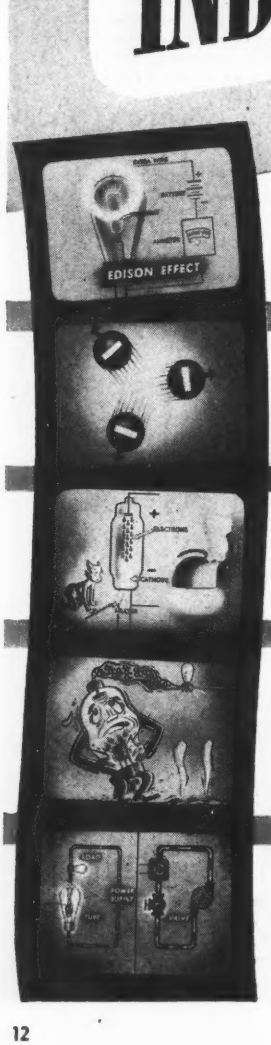
YARWAY STEAM PLANT EQUIPMENT

GENERAL ELECTRIC

Announces

A 12-PART TALKING SLIDEFILM COURSE in INDUSTRIAL ELECTRONICS

THESE 5 ILLUSTRATIONS AND (RECORDED) CAPTIONS are typical of the simple, interest-arousing sequences. 100 in each slidefilm.



When the lamp is lighted and the filament glows, current flows through the extra wire, even though it is not connected with the filament itself. This phenomenon (Edison Effect) demonstrates the underlying principle of electronic tubes.

Electrons, being negatively charged particles, repel each other and hinder the flow of other electrons from cathode to anode. This repelling action is called "space-charge"—a factor of very great importance in electronic-tube design.

In some types of electronic tubes, we "boil" the electrons out of the cathode with heat, much as boiling water produces steam.

A gas-filled tube (phanotron) can be damaged if forced to operate before its cathode has been heated sufficiently to emit the required amount of electrons. To prevent such abuses, most electronic equipments have automatic timers built in to protect rectifier tubes.

In our electric circuit, we use a second voltage supply called the control, or grid, voltage. It performs much the same function as the control handle on the valve in a hydraulic circuit.

. . visualized for easy understanding, even by non-technical people

. . packaged for easy instruction, using your own "home-talent" leaders

. . practical up-to-the-minute subject matter, technically authentic

Now, an understanding of electronics as applied in industry can be built up, right within your organization, using the ingenious techniques of *visual instruction* that have proved so successful for wartime training. Every sequence of this 12-part course has been put to test on groups of widely different education levels. Educators have joined practical plant executives in praising its combination of *easy understanding* and *technical accuracy*.

As you follow the instruction manual, the sessions almost "conduct themselves," so that no great experience in organizing or instructing people is necessary. Everything essential is furnished except a sound slidefilm projector (35 mm, 33⅓ rpm), screen, and a meeting place. Upon completion of the course, your people will have a well-rounded acquaintance with electronic devices, tubes, circuits, and applications.

ALL THESE WILL BENEFIT

As electronic apparatus is applied more and more widely to industrial plants and processes, more and more of your people—from managers to maintenance men—will find their work depending upon electronics in a very practical way. Some of them must learn to service this equipment. Others will be better equipped to get the most out of electronic equipment when it is no longer "all a mystery" to them.

PLANT ELECTRICIANS and maintenance men will find the course understandable, even if their knowledge of electrical theory is limited. In learning about electronics and its application, they'll get a background of fundamentals of electricity, too.

PLANT AND DESIGNING ENGINEERS will find the course stimulating in suggesting practical electronic applications to improve processes or products.

PRODUCTION MANAGERS and foremen will get a clearer concept of the workings of equipment for which they are responsible. New process control ideas may also be suggested.

EXECUTIVE MANAGEMENT and purchasing agents can get a clearer concept of practical electronic possibilities. They will be in a better position to consider and approve recommendations.

SALESMEN selling electronic products will be better equipped to talk to their customers.

Note: *ELECTRICAL UTILITY COMPANIES* and electrical associations in many communities are organizing inter-company groups for this course of instruction. You may want to check with your local utility on this point.

THESE ARE THE 12 SUBJECTS OF INDIVIDUAL FILMS AND LESSON BOOKS

1. Harnessing the Electron
2. Electronic Tubes as Rectifiers
3. Grid Control of Electronic Tubes
4. Fundamentals of Electricity, Part I
5. Fundamentals of Electricity, Part II
6. Electronic Relay Systems
7. Electronic Rectifier Equipment
8. Thy-mo-trol (Thyratron Motor Control)
9. Electronic Control of A-c Power
10. Electronic Frequency Changing
11. Photoelectric Systems
12. Electronics, Today and Tomorrow

Here's what you get

12 SLIDEFILMS AND RECORDED TALKS—each about ½ hour long

300 REVIEW BOOKLETS—25 sets of 12 individual lessons, keyed to the slidefilms

1 INSTRUCTOR'S MANUAL—a 140-page book with hundreds of illustrations and detailed steps for conducting the course

1 CARRYING CASE—attractive and strongly built, it holds records, films, and manuals

THE PRICE—for the complete "package" as above, $100; *extra* manuals, $3; *extra* sets of 12 *review booklets*, $2

ORDERS—can be placed through any local G-E office, or use the coupon below.

GENERAL ELECTRIC

BUY ALL THE BONDS YOU CAN—*AND KEEP ALL YOU BUY*

General Electric Company
Apparatus Dept., Section D685-13
Schenectady 5, N. Y.

—Enclosed is our order for ..... complete INDUSTRIAL ELECTRONICS courses at $100 each (May be returned without charge if you are not fully satisfied.)

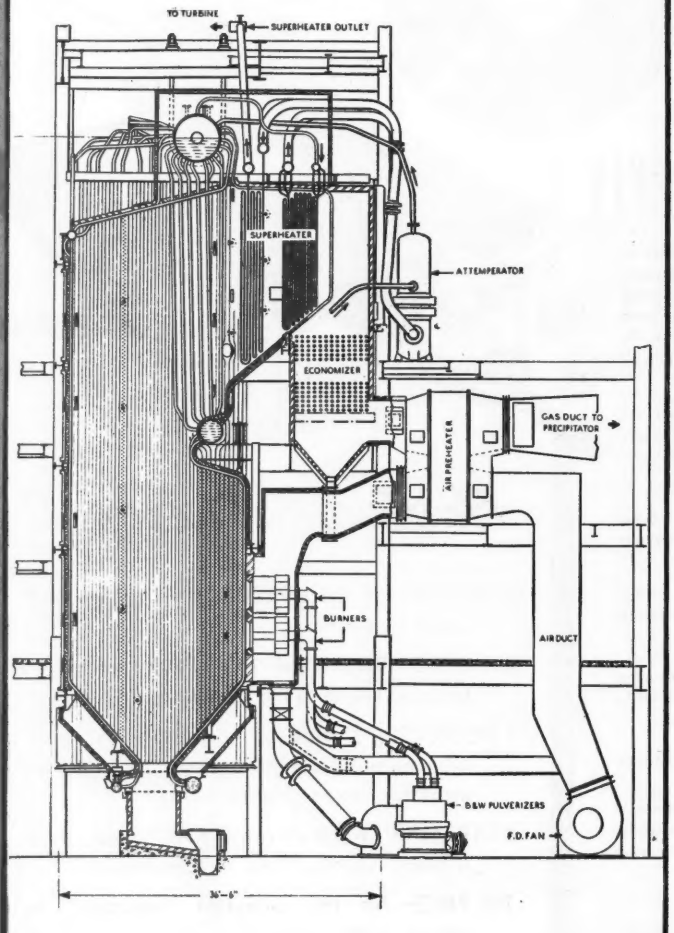
—When could someone in our organization see a showing of one of these lessons and examine the complete kit?

Name.....

Company.....

Address.....

REPORT FROM RIVERSIDE: "unusually

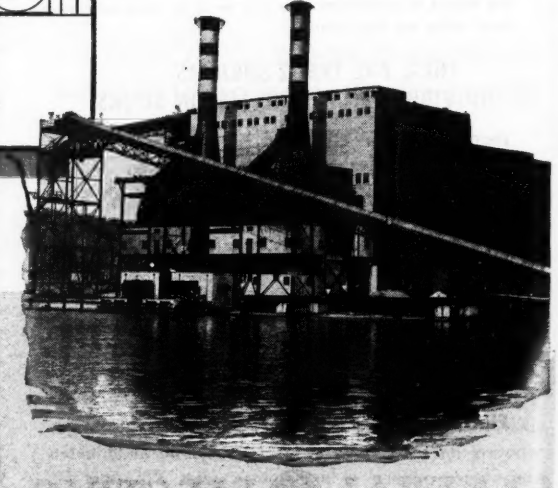


Arrangement of B&W Radiant Type Boilers No. 1 and 2 at Riverside Station and No. 3 at Westport Station of Consolidated Gas Electric Light and Power Company of Baltimore. Rated capacity of each boiler: 550,000 lb per hr at 900 psi and 915 F at superheater outlet. Units are equipped with B&W superheaters, attemperators, economizers, and burners. Three B&W Type E Pulverizers supply fuel for each boiler.

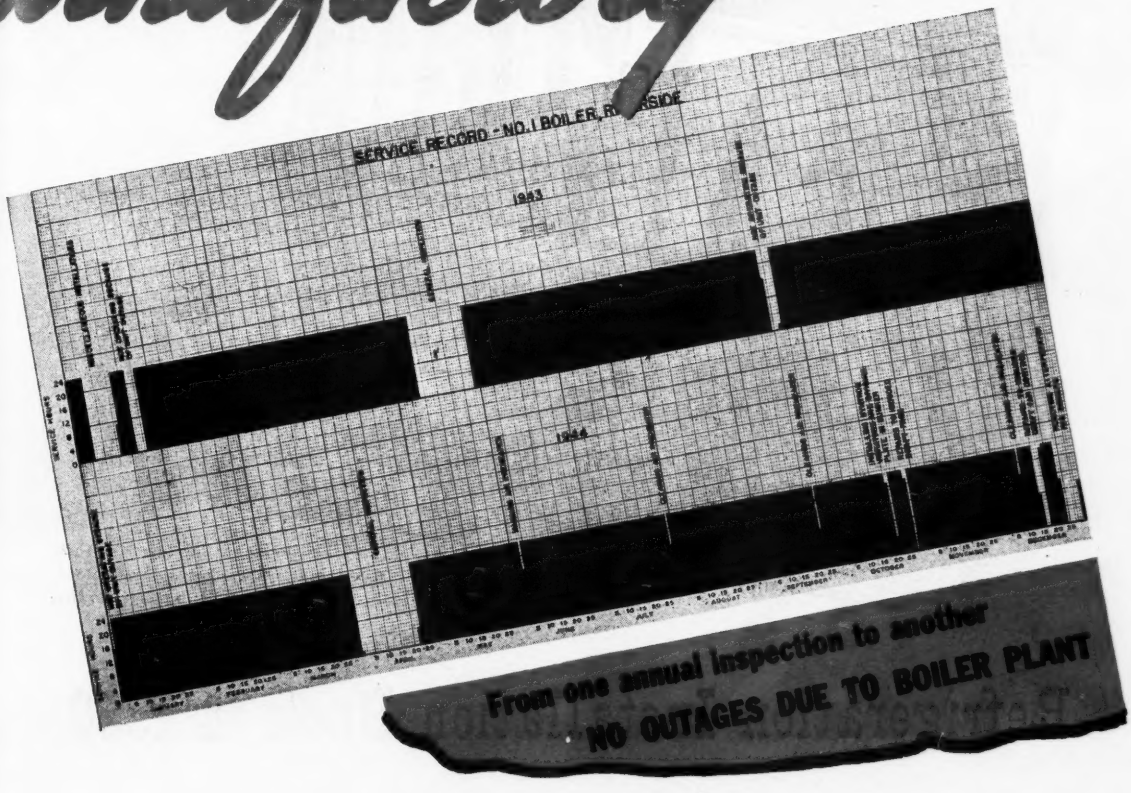
A large factor in meeting increased power demands of the war-busy area of 2,300 square miles served by Consolidated Gas Electric Light and Power Company of Baltimore, is its new Riverside Station. Here, two 550,000 lb per hr B&W Radiant Type Boilers serve two 60,000-kw turbine-generators.

Service records of these boilers to date show a high degree of availability—*in one period between annual inspections, the boiler plant was not responsible for a single outage.* And, the design of these boilers resulted in ". . . slag-free operation of these units which is the more remarkable in view of the wide variety of coal which the war has made necessary and which includes coal containing ash with an initial deformation temperature as low as 1900 F and as high as 2800 F".

Such service records stem from equipment well matched to its job from the start. Riverside's first B&W boiler went into operation in December 1942; the second in April 1944. Both met or exceeded rated capacities and within two weeks following initial operations were, in the



satisfactory"



words of the Company's engineers, "just units on the line". Performance of the boilers, in spite of handicaps imposed by war conditions, has fully met expectations. There has been no difficulty in obtaining rated output over prolonged periods. In fact, "operating experience with these steam-generating units is unusually satisfactory," say company officials.

Experience at Riverside is being duplicated by a similar B&W unit at the Westport Station of this Company. Results with these units are not exceptional, but are being repeated by B&W boilers in public utility stations all over the country—reflecting the high standard of performance that has been built into B&W steam-generating equipment for over 60 years.

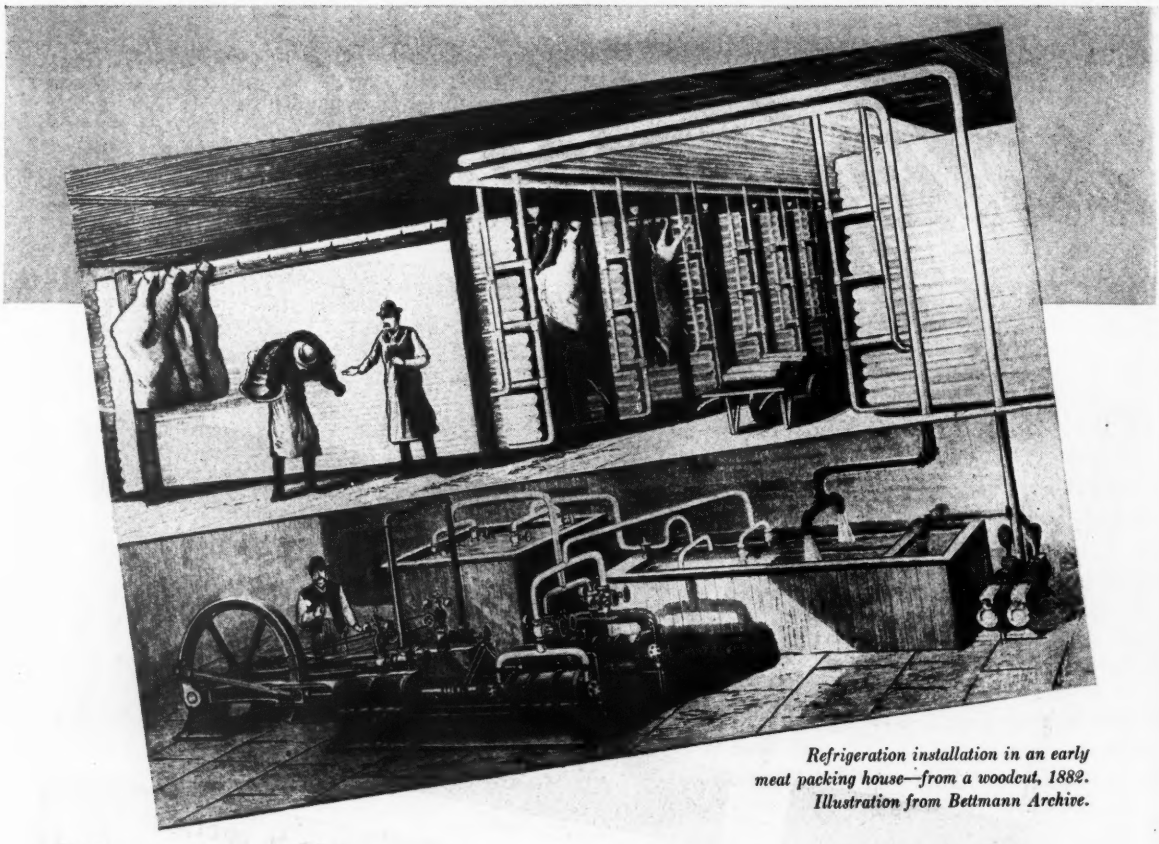
Thinking and planning for tomorrow *today* is a job that B&W engineers are ready to tackle—in partnership with your engineers—at any time.

G-310T

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

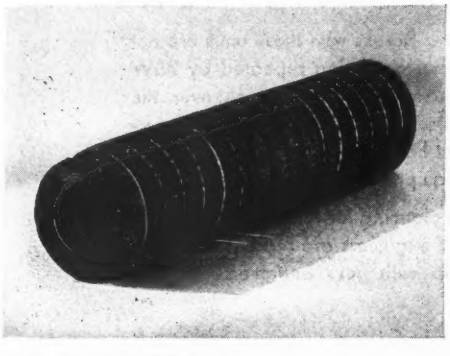
BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
85 LIBERTY STREET, NEW YORK 6, N.Y.



Refrigeration installation in an early meat packing house—from a woodcut, 1882. Illustration from Bettmann Archive.

Refrigeration Installation Back in 1880



GARLOCK 778 (*illustrated*) is an ammonia packing made of closely woven duck and rubber. Other Garlock packings for ammonia service are of metal foil or semi-metallic construction.

The development of centralized refrigeration methods shortly after the Civil War gave rise to the modern meat packing industry. Then, as today, continuous operation of cold storage equipment was vital.

GARLOCK Packings and Gaskets were used in refrigeration plants and many other infant industries over a half century ago—and today GARLOCK products are used in *hundreds of different industries*, helping to keep production running efficiently by reason of their long life and dependable performance.

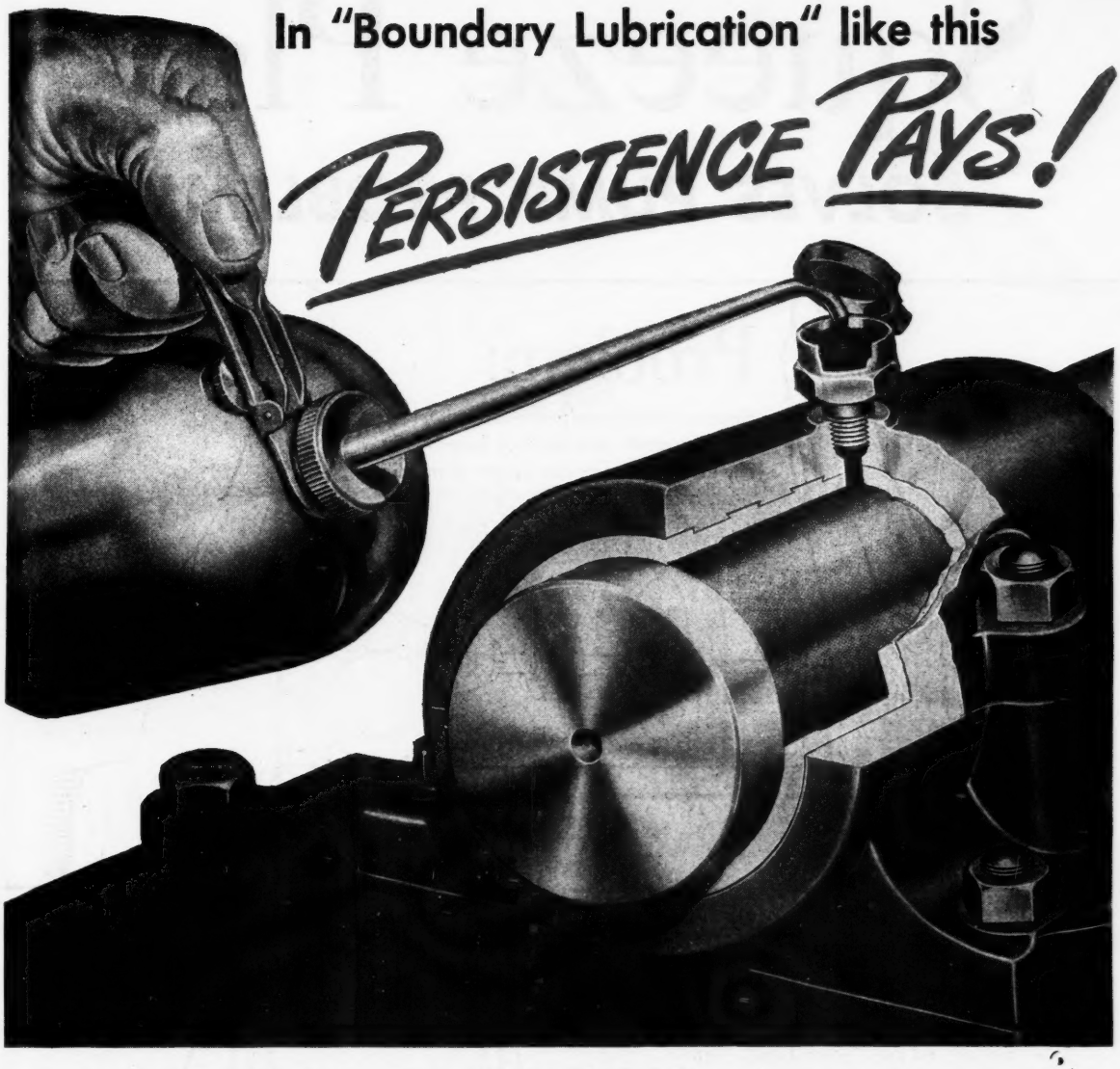
THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada, Ltd., Montreal, Que.

Garlock

In "Boundary Lubrication" like this

PERSISTENCE PAYS!



LOOK THROUGH your plant. You'll find many vital plain bearings where lubricants are applied by hand or by drip-feed devices.

Here the oil drains rapidly, leaving only a microscopic thin film to protect the bearing until the next application. This is called "boundary lubrication," a condition that calls for special oils with a strong attraction to metal.

The answer is Gargoyle Vactra Oils, tailor-made for this "boundary lubrication" problem. These outstanding general-purpose oils form strong, persistent films that adhere to the metal, and resist wiping action and rupture, even when squeezed to microscopic thinness. Applied to all kinds of machinery by hand, bottle-oilers and drop and wick-feed cups, they reduce friction, wear and power consumption to a minimum. See your Socony-Vacuum Representative. Get this persistent protection.

SOCONY-VACUUM OIL CO., INC., Standard Oil of N.Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. • White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California.

SOCONY-VACUUM'S 5 Steps to Lower Production Costs:

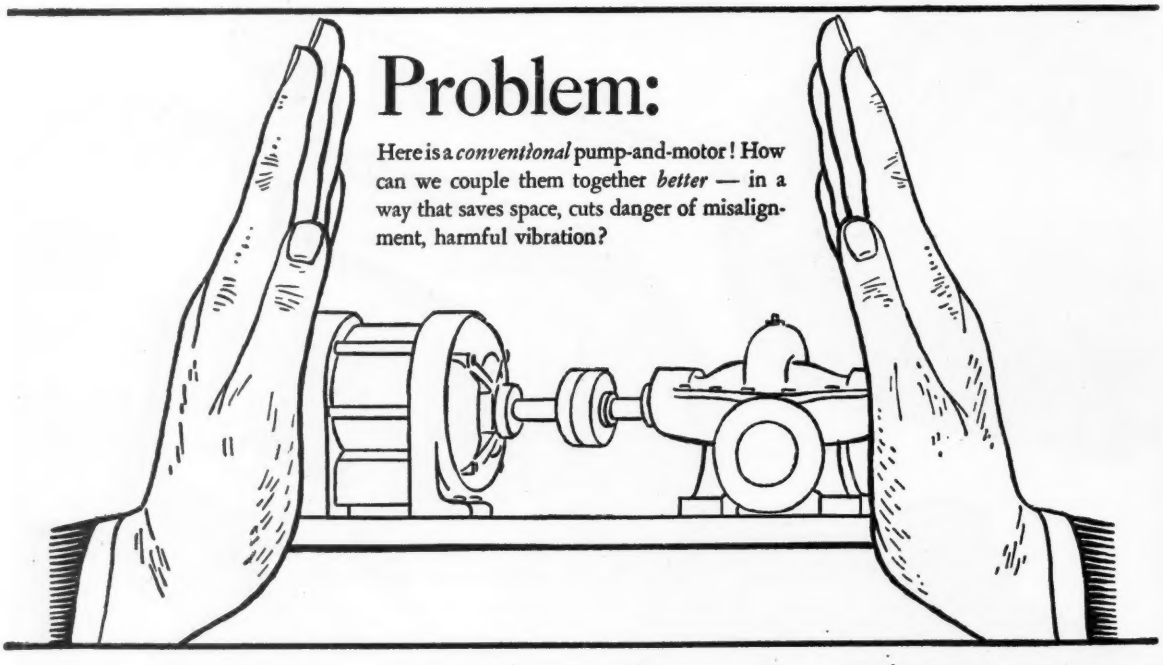
1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured

GARGOYLE Lubricants

TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.W.T.—NBC

Squeeze Play

SOLVES PUMP PROBLEM!

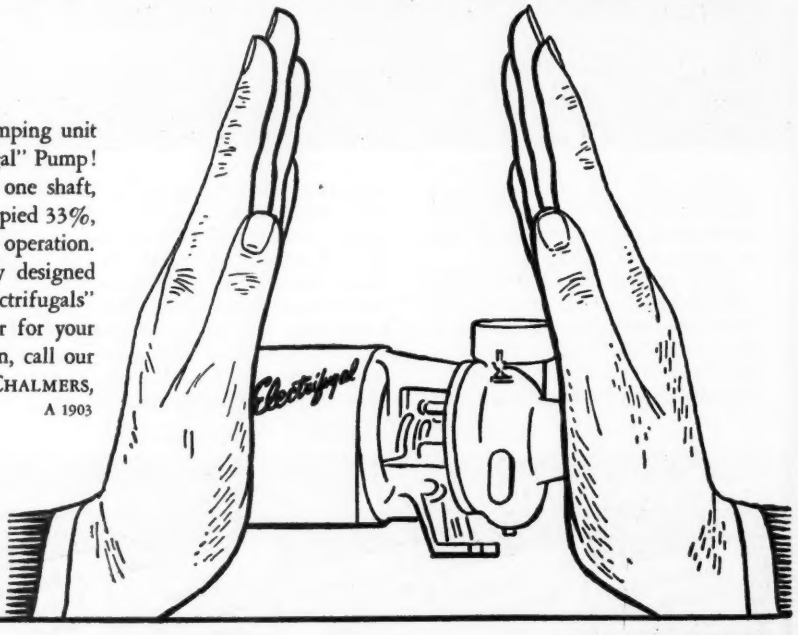


Problem:

Here is a *conventional* pump-and-motor! How can we couple them together *better* — in a way that saves space, cuts danger of misalignment, harmful vibration?

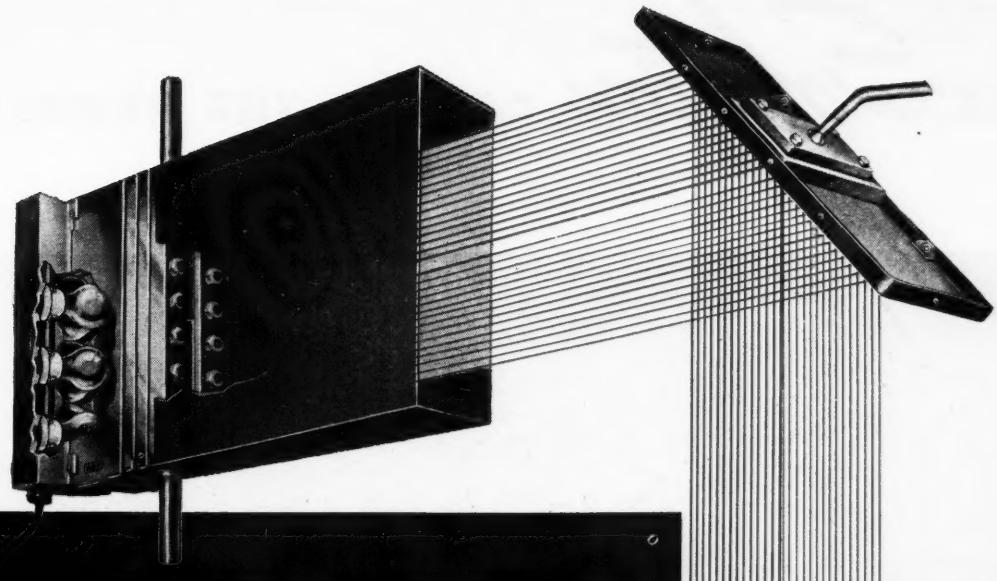
Solution:

We design a *new kind* of pumping unit — the one and only "Electrifugal" Pump! Motor and pump are now on one shaft, one frame. That cuts space occupied 33%, assures alignment and smooth operation. Splash-proof motor is specially designed for pump drive. No wonder "Electrifugals" give you more pumping power for your money! For further information, call our nearby office, or write ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 1903



ALLIS CHALMERS *ELECTRIFUGAL* PUMPS

Reconversion Problems? Write A-C for free Reconversion Inventory Kit for all makes of pumps, motors, V-belts!



for ABSOLUTELY ACCURATE
remote reading of boiler water level...

the DIAMOND
BI-COLOR WATER GAUGE
AND ILLUMINATOR

Using the simple optical principle of the difference in refraction (bending) of light rays passing through water and through steam, the Diamond Bi-Color Water Gauge always shows steam as red and water as green. Because the optical law is invariable, the contrasting colors in the glass are a completely reliable indication of water level at all times—changing instantly as water level changes, without the slightest lag.

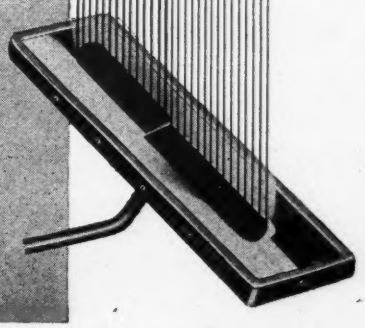
The image is so sharp and clear that it can be mirrored to the firing floor from any height—through as many as three grating runways without slightest confusion. Lower mirror can be made a part of boiler control panel. Installation is very easy and the Diamond Bi-Color can be readily substituted for most existing water gauges, whether of Diamond or other manufacture.

The Diamond Bi-Color Water Gauge requires no attention . . . it has no moving parts. No calibration is necessary and variation in the specific gravity of water has no effect upon it.

Ask for Bulletin 892-B which shows why there are now more than 2000 Diamond Bi-Color Water Gauges installed in power plants all over the country.

STEAM SHOWS RED

WATER SHOWS GREEN



DIAMOND POWER SPECIALITY CORP.
DETROIT 31, MICH.
DIAMOND SPECIALITY CORPORATION, WINDSOR, ONT.

THE *Solution* CAUSED THE PROBLEM

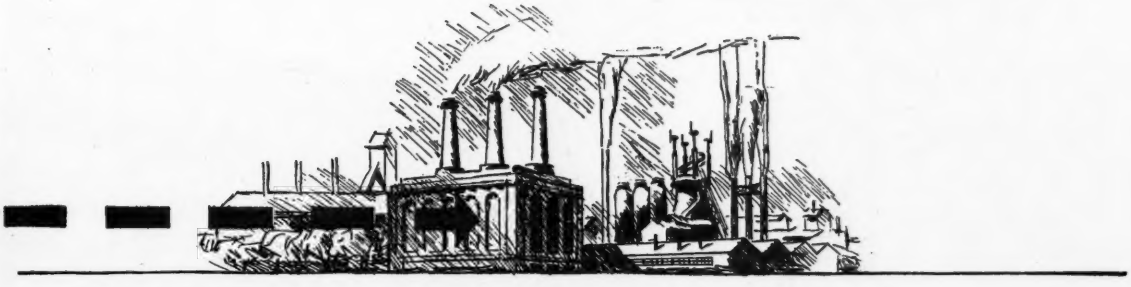
HERE'S WHAT HALL CLIENTS GET:

1. Thorough study of all factors concerning water involved in producing steam.
2. Procedure for the proper treatment of boiler water.
3. Instruction of designated employees in making of essential control tests.
4. Periodic check up by Hall service engineers.
5. Periodic checking of samples by Hall Laboratories.
6. "Trouble shooting" that includes all service necessary as problems arise.

—all of which adds up to boilers that stay on the line!

HAGAN
HALL
BUROMIN
CALGON

IN THIS STEEL MILL POWER PLANT



The boiler water was okay, so the plant engineer was satisfied.

The Hall service engineer was not. He found that the plant was using 110 pounds of phosphate daily, and he knew that it should not be more than 50 pounds a day, at most.

His check-up showed that there were no raw water leaks, and no sludge in the water coming from the softener. As a final point in his checking, he brought to Pittsburgh a sample of boiler water and also a sample of the molybdate solution used in testing it.

When analysis of the boiler water showed a great excess of phosphate, Hall chemists turned to the molybdate solution the mill had been using in its own tests.

It was quickly evident that the solution was the source of the trouble. This had been supplied by the mill's own laboratory, and instead of following Hall instructions as to strength the laboratory had made up the same weak solution required for certain steel tests. As a result, tests made with this solution indicated a need for far more phosphate than was actually required.

The Hall service engineer had already arbitrarily reduced the amount of phosphate used to 75 pounds a day. Now, on the basis of accurate tests, it was reduced to less than 50 pounds.

Hall service engineers take nothing for granted. They check all factors involved in boiler performance, and, in the event of trouble of any kind, they trace the trouble to its source.

Every plant that generates its own steam power can profitably use Hall Service.

Write us for full information.

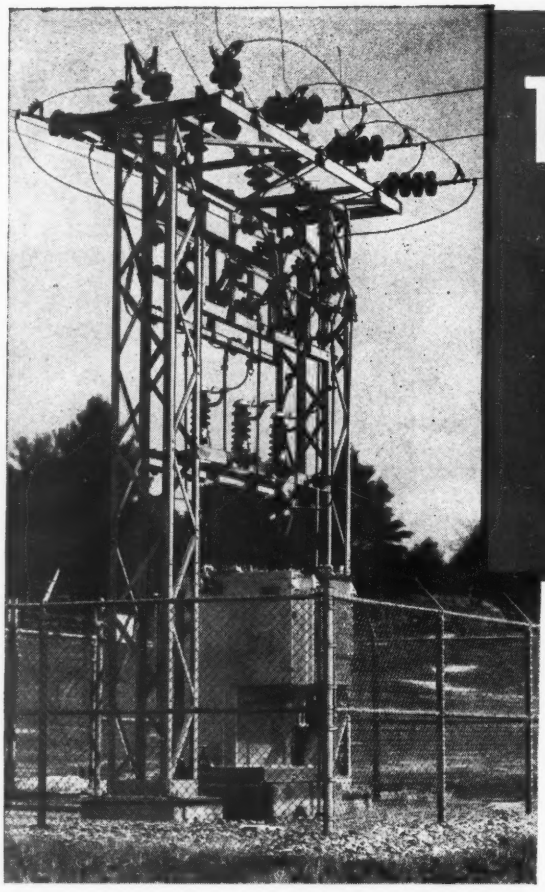
HALL LABORATORIES, INC. · HAGAN BUILDING · PITTSBURGH 30, PA.

A subsidiary of Hagan Corporation

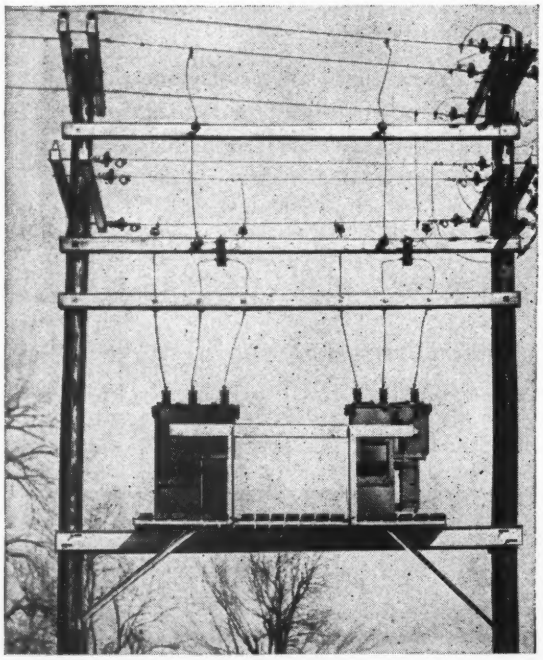
HALL SYSTEM *of Boiler Water Conditioning*

The RIGHT VOLTAGE at

Here's every type of regulator you need, to have the right voltage—anywhere



STEP REGULATORS (MLT-32)—For urban and rural circuits 69,000 volts and below. Provide 10% regulation raise *and* lower in thirty-two 5/8% steps. Ratings 104 to 750 kva, three-phase.



BRANCH STEP REGULATORS (ML-4)—For very low-cost regulation; 10% raise or lower in four 2½% steps on 2400-, 4800-, and 6900-volt feeders. Up to 51.8 kva, single-phase.

● It is now easy and inexpensive to extend the benefits of good voltage to every point of your distribution system—or to every nook and corner of your plant. Whether you need voltage regulation for urban feeders, rural lines, factory circuits, or laboratory, there is a simple, economical G-E device for the job.

A few ways these devices may be able to help you:

ON PRIMARY CIRCUITS

1. As an aid in maintaining service standards and keeping customer good will in the face of wartime distribution problems. Also, to iron out feeder-voltage problems.

2. To find "hidden kilowatts" (by releasing extra system capacity) without revamping present lines or adding new feeders. They're a "natural" for voltage problems that must be solved quickly. They make possible more effective use of equipment already on a system.

3. To make your system capacity more adaptable for postwar loads. Sudden shifts in population, drops in wartime loads or increased domestic and commercial loads can be taken care of more easily—often without changing generator or transmission facilities.

4. To reduce system costs. Actual case histories show annual savings of from $834 to $9950 on a single feeder.

ON SECONDARY CIRCUITS

1. For improved lighting (more constant light level); for better starting of fluorescent lighting; for increased lamp life;—by holding voltage at the proper level.

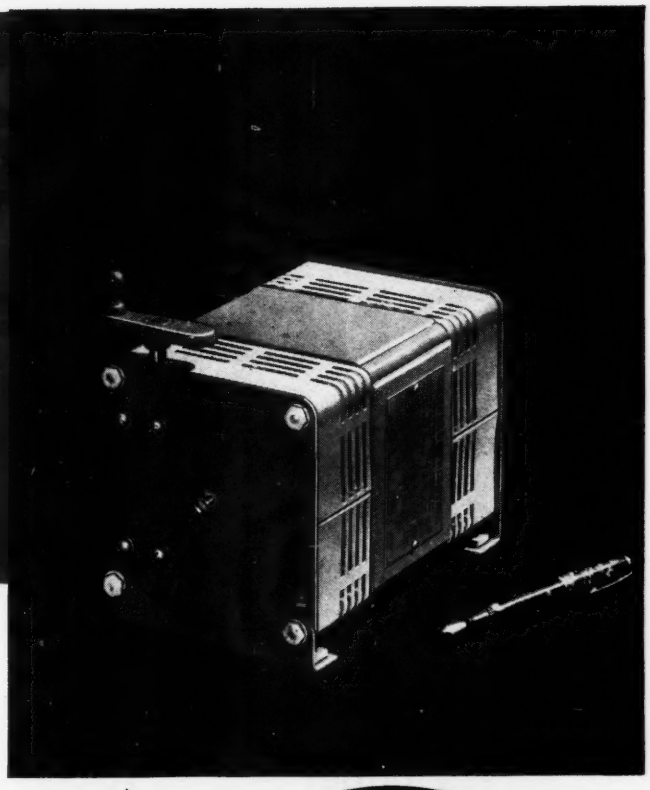
2. For greater production—by eliminating sluggish operation of motors and potential or control devices.

3. For longer life of electric equipment; for protection of precision electric devices, electronic tubes, etc;—by reducing overheating and burnouts.

4. For the right voltage in your laboratory to assure accurate test results in less time.

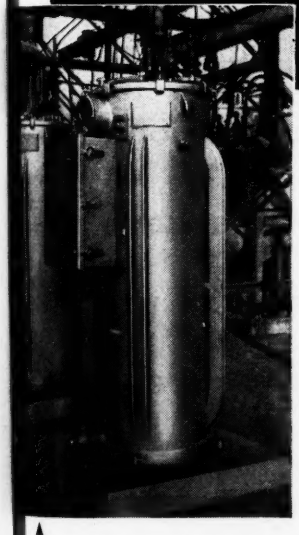
The regulators shown at work on these pages are only representative of the many G-E voltage-improvement devices that are available to help you. We shall be glad to help you analyze your voltage problem to determine what corrective measures are necessary. *General Electric Company, Schenectady 5, N. Y.*

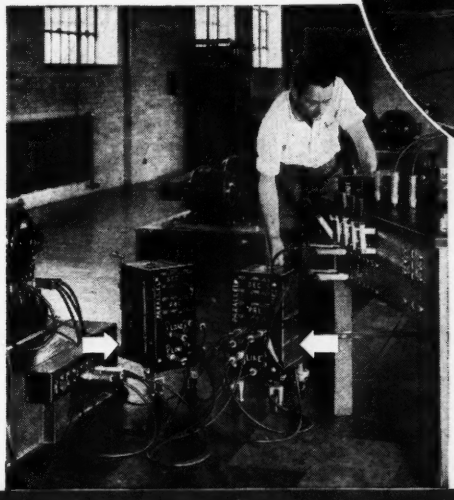
the RIGHT PLACE Does the Job BETTER



SMALL DRY-TYPE REGULATORS—For 120- and 240-volt circuits. 10% raise and lower or 100% raise and lower regulation. Up to 600 va, single-phase. 10% ratings available for automatic operation.

VOLTAGE STABILIZERS—Automatically provide a constant 115- or 230-volt supply to a given load, on circuits varying from 95 to 130 or 190 to 260 volts. Ratings from 50- to 5000-va output.





INDUCTION REGULATORS (IRS—oil-type or Pyranol for indoor or outdoor use)—Provide 10% regulation raise and lower on 2400-, 4800-, and 6900-volt feeders. 12 to 120 kva, single-phase. Also available three-phase.

VARIABLE-VOLTAGE AUTOTRANSFORMERS — Provide smooth, adjustable control of voltage, current, light, temperature, power, and speed at a turn of the dial. Ratings from 243- to 810-va output for 115- and 230-volt circuits.

DRY-TYPE REGULATORS (AIRS)—For secondary circuits. *Automatic type:* Provides 10% regulation raise and lower. *Remote-motor or hand-operated:* 100% raise and lower. Up to 12 kva, 600 volts, single-phase. Also available three-phase.

GENERAL ELECTRIC

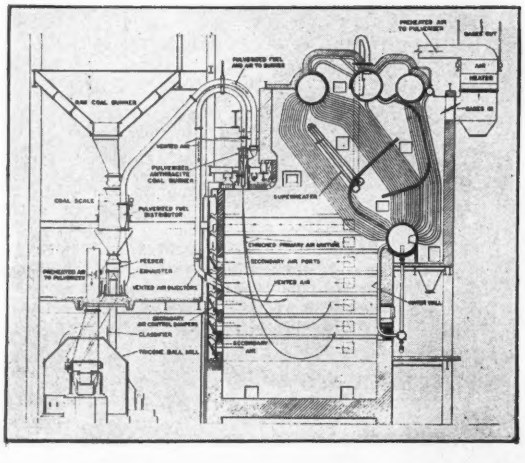
Blazing THE

DIRECT FIRING of

1935

The first Direct Fired Installation of Pulverized Anthracite was made in a large New Jersey paper mill in 1935.

Six more industrial installations have since been made to fire pulverized anthracite with this same FW system in capacities up to 175,000 lb. of steam per hour.



Important savings have been realized from the use of low grade anthracite and a new source of fuel has been made available.

FW FOSTER

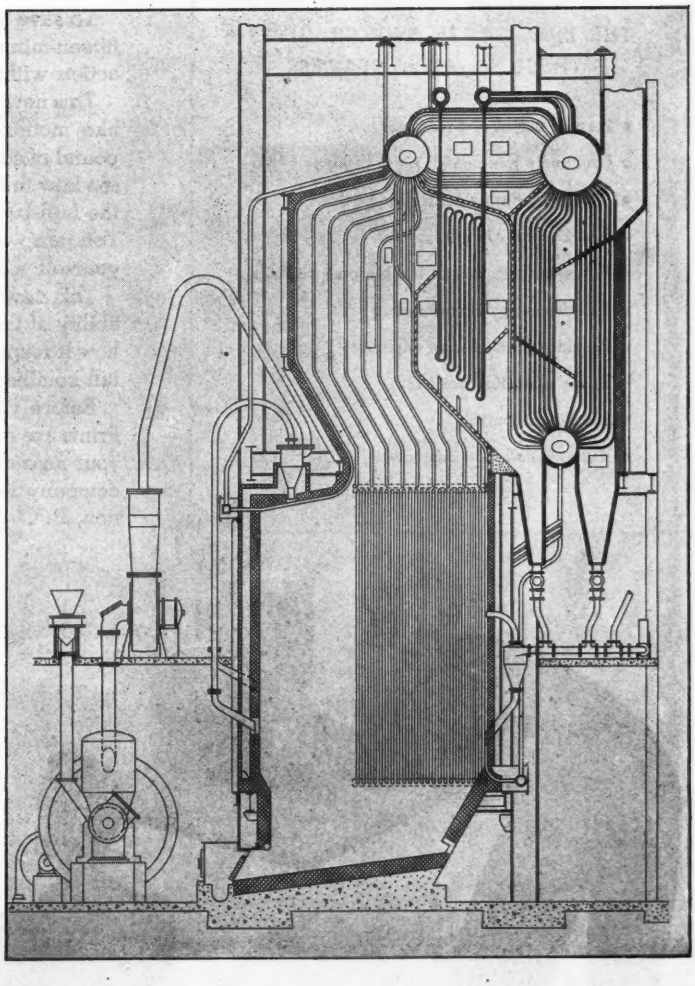
ENGINEERING TRAIL

Pulverized ANTHRACITE

1945

First Central Station Steam Generator for the Direct Firing of Pulverized Anthracite Coal.

Two Units for the Hunlock Creek Plant of the Luzerne County Gas & Electric Co. for 175,000 lb. per hour of steam each.



FOSTER WHEELER CORPORATION
165 BROADWAY • NEW YORK 6, N. Y.

WHEELER FW

SEE A *Link-Grate* STOKER ...Right in Your

YOU'LL SEE IN THIS MOVIE WHY THE LINK-GRATE STOKER GIVES THESE 10 ADVANTAGES

- Permits use of low-cost fuel
- Effectively handles all types of loads
- Assures accurate control of air flow
- Fuel bed flow is unrestricted
- Prevents formation of troublesome clinkers
- Ash discharge is continuous
- Provides high reserve capacity
- Keeps operating costs low
- Simplifies control
- Keeps installation cost low

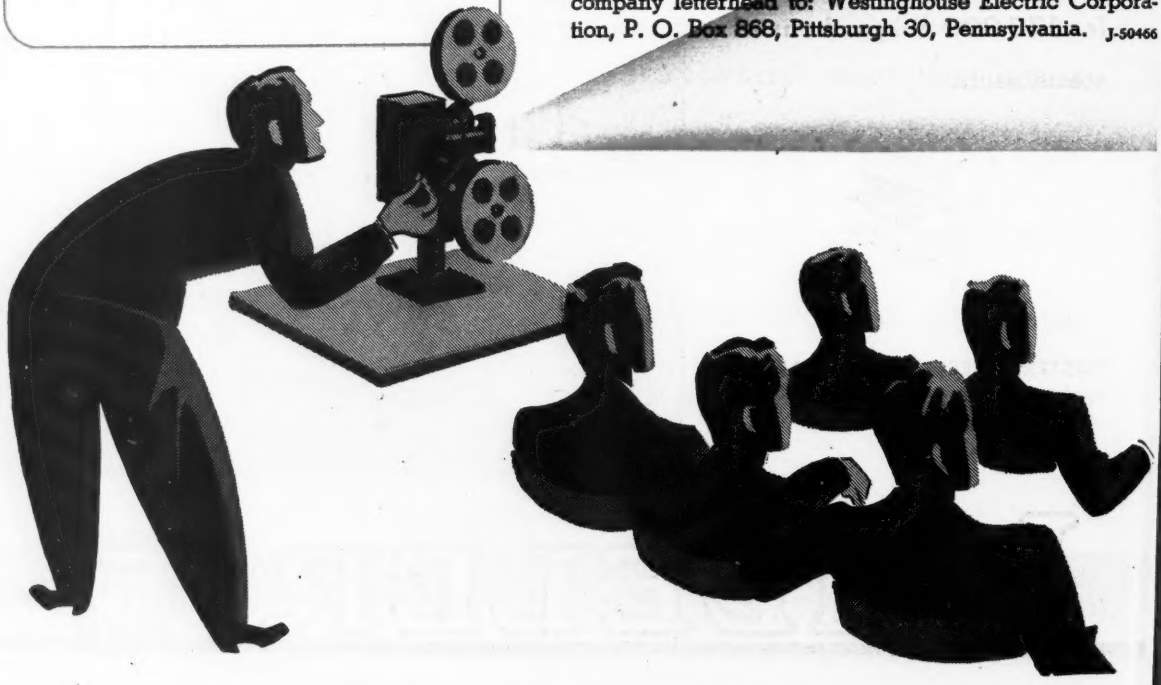
Of course, the best way to see the advantages of the Link-Grate Stoker is to visit a power plant and watch one in operation. But these are busy days. Time is precious.

To save your time, Westinghouse has produced a new fifteen-minute movie which lets you see a Link-Grate in action without leaving your office.

This new 16mm. sound film clearly shows why the wave-like motion of the Link-Grate means more steam per pound of coal and why you can use low-cost fuel. You can see how the upward motion of the Link-Grate breaks open the fuel bed to keep it porous and permit free air flow. You can watch the continuous ash discharge and see for yourself why the fire is always clean and active.

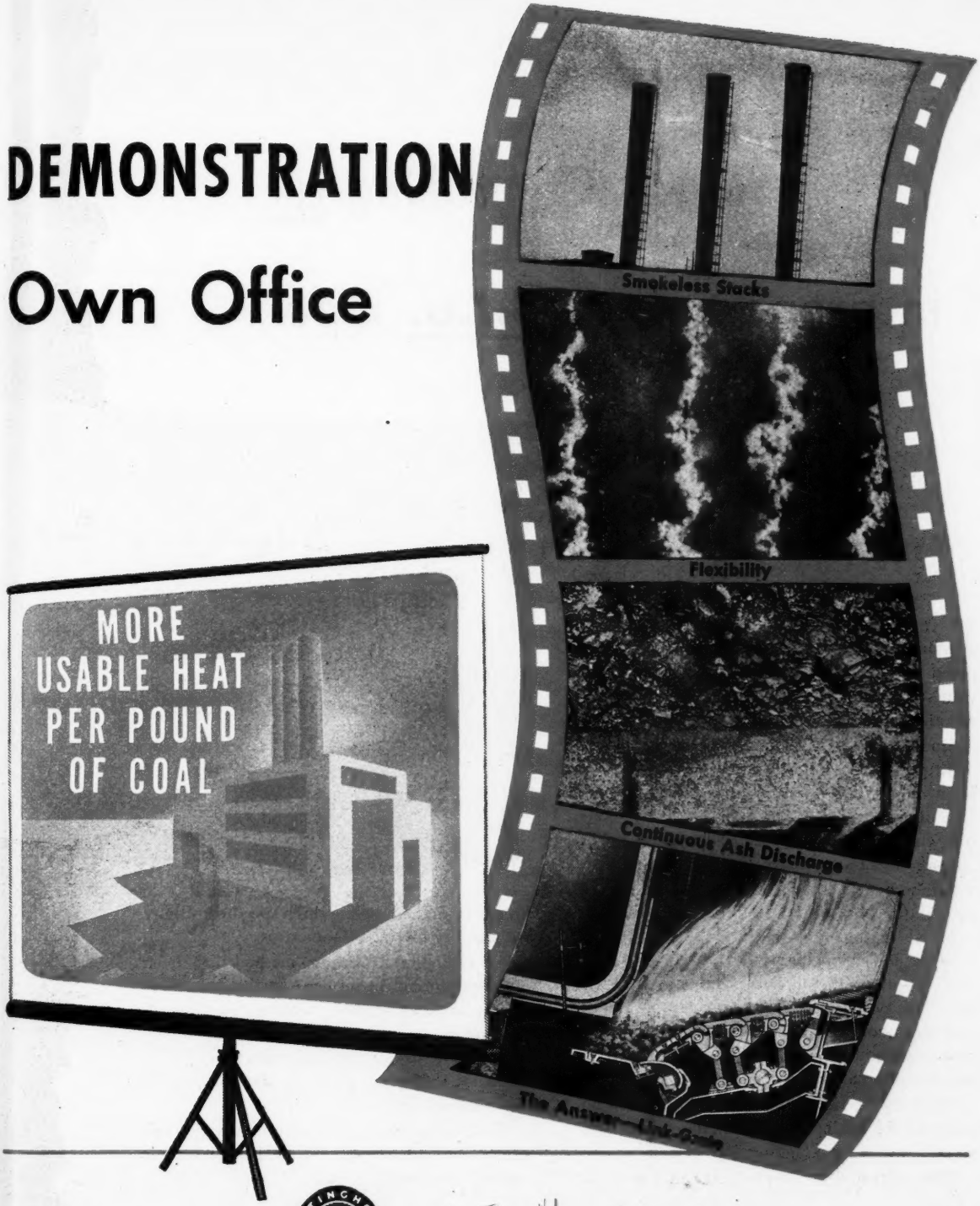
This new movie also illustrates simplicity of control and ability of the Link-Grate to handle all types of loads, and how it responds quickly to increased steam demands with full combustion efficiency.

Before you buy any stoker be sure to see this movie. Prints are available on loan for your private showing from your nearest Westinghouse office. Or write direct on your company letterhead to: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50466



DEMONSTRATION

Own Office



Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Link-Grate STOKERS

Controlling air in proportion to B.t.u. input

A report on the Hagan Differential Master Method of Combustion Control

IN THE FIRING of pulverized coal the accurate maintenance of fuel-air ratio has been hampered by such factors as variation in calorific value of coal, and coal feed mechanisms which are affected by moisture content and coal size.

Since it is a known fact that the air requirement per pound of fuel is directly related to its B.t.u. content, it is possible to overcome this difficulty by a simple and *direct* method of control which for the first time employs the steam flow-air flow relationship *correctly*.

Although not universally applicable, where this relationship can be applied the Hagan differential master method uses the boiler unit itself as a calorimeter of heat input and correctly regulates the air in a positive, *direct* manner. This permits the immediate establishment and continuous maintenance of the correct conditions without relegating the principle to the position of an after correction.

By doing it right the first time there is no necessity for setting up approximate conditions to be handled by a lagging corrector system.

The successful accomplishment of this stems directly from the inherent, high speed, sensitivity and stability of Hagan apparatus.

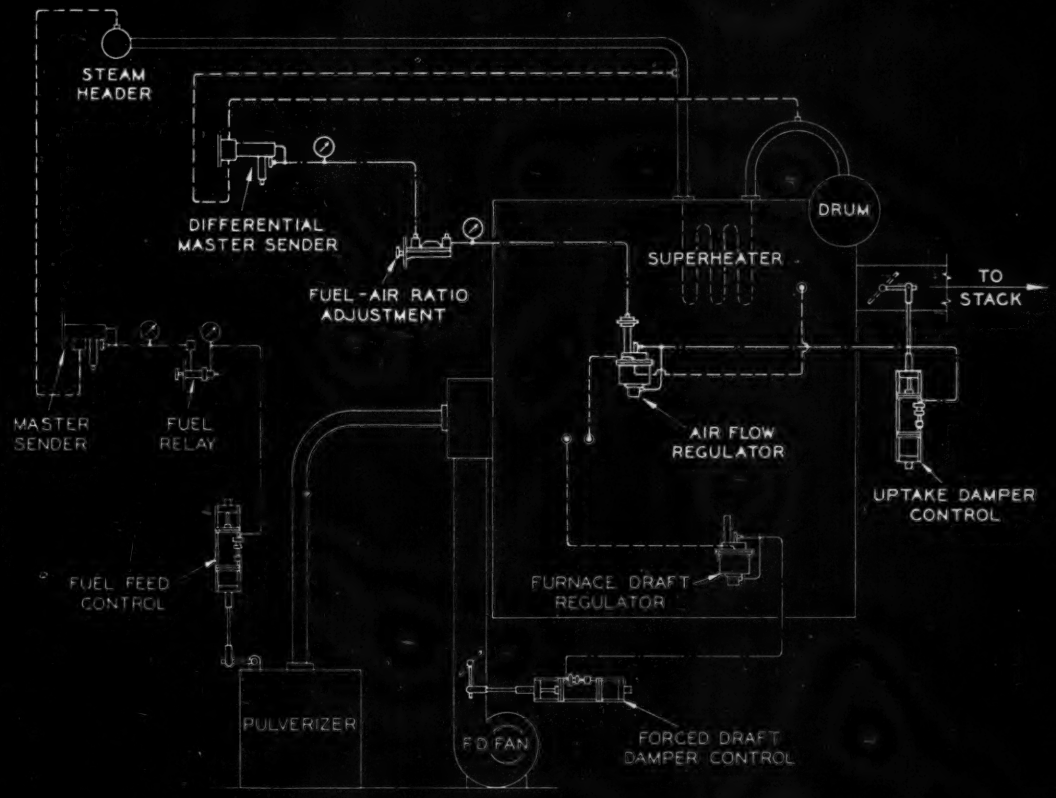
The Differential Master method has been thoroughly tested in service. In the past three years it has been applied to boilers burning oil, gas, and pulverized coal. Boiler sizes ranged from 30,000 lbs./hr. at 200 p.s.i. to 650,000 lbs./hr. at 1800 p.s.i. In every instance, results have been entirely satisfactory.

This development again emphasizes Hagan's continuing leadership in the field of automatic combustion control.

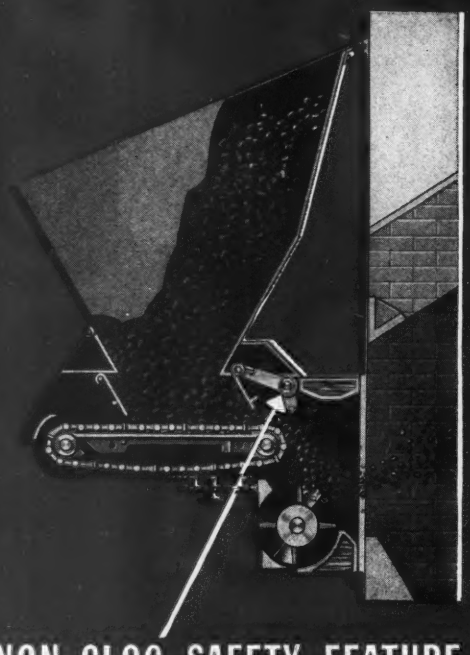
HAGAN CORPORATION, HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader



HAGAN
HALL
BUROMIN
CALGON



NON-CLOG SAFETY FEATURE PREVENTS JAM-UPS

Tramp iron and other foreign objects in your fuel won't jam up and damage the Æ Perfect Spread Stoker. Small objects pass right through onto the grate, while infrequent larger pieces stop the feeder without harm. The feeder can be cleared and started again by simply lifting the cover and making a minor adjustment—without special tools—without removing the mechanism. This exclusive Non-Clog Safety Feature gives you quiet, uniform operation and non-stop firing.

BURNS ALL KINDS OF SOLID FUEL

WHY WORRY ABOUT coal availability and prices? Here's a stoker that efficiently burns so many kinds and grades of solid fuels, that you can easily keep up with changing conditions while producing more steam at lower cost.

It's the Æ Perfect Spread Stoker, a compact, completely automatic fuel-firing unit for high or lowest grade coals, coke breeze or sawdust. You can even burn corn cobs, hogged fuel, wood refuse, plant refuse and by-products for still greater economy.

This dependable, extremely quiet-running stoker has many more features that may fit perfectly your present and future needs. Because its advanced design is "streamlined" in appearance, principle and operation, it also "streamlines" your fuel bills and boiler room practices. Be sure to get *all* the details. Write today for the Æ Perfect Spread Stoker bulletin.

If Your Steam Requirements Call for 175 H. P. up to 200,000 lbs. per hour—

YOU NEED THIS BULLETIN

Write us. 2408 Aramingo Ave., Philadelphia 25, Pa.

Æ PERFECT SPREAD STOKER

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PA.

IT COSTS NOTHING TO FIND OUT HOW TO...

SAVE on POWER COSTS

IF COSTS — consistent with dependability and quality—are to be the basis of your new power plant equipment, then you want to know how to save on stoker installation and operation, while producing more steam more economically.

You may find the answer to your specific problems in the improved Taylor Stoker—a stoker with many new features and advantages supplementing its time-tested and proved principles of combustion. Each of these improvements is worth studying in detail . . . for details often mean the difference between choosing a stoker for the job, and choosing the *best* stoker.

The new Type "R" Taylor Stoker booklet costs you nothing and may save you much. Write for it today . . . it will be sent without delay.

IF YOUR Steam Requirements Call for 20,000 to 500,000 lbs. per hour—

YOU NEED THIS BOOKLET

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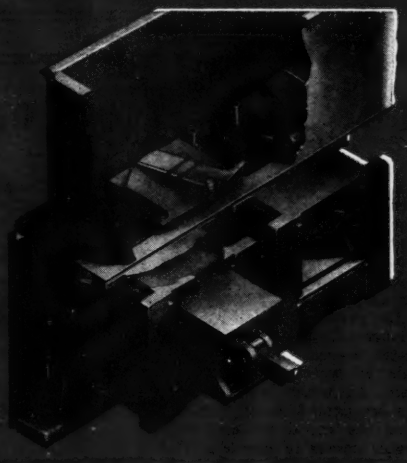
ANOTHER IMPROVEMENT IN THE TYPE "R" TAYLOR STOKER



AGITATOR PREVENTS B-R-I-D-G-I-N-G IN COAL HOPPER

Wet or partially frozen coal is prevented from packing and "bridging" in the stoker hopper by unique agitators. Operated by alternating strokes of the coal rams, a series of oscillating agitators located between the rams prevents bridging and keeps coal flowing. Each coal ram gets a *full* charge every stroke and a uniform fuel bed is maintained.

AE TAYLOR STOKERS

AIR-COOLED & WATER-COOLED

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PA

COPPER ALLOY · BULLETIN

MARINE AND POWER EDITION

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared by Bridgeport Brass Company — "Bridgeport" BRASS CO. — *Headquarters for BRASS, BRONZE, and COPPER*

Effect of Temperature on Tube Life

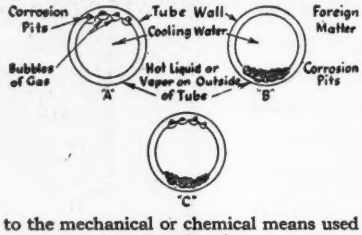
The rate of corrosion is generally increased by rising temperature. This was discussed in the August issue. Yet, there are circumstances where an elevated temperature is responsible for reducing the corrosion rate. For example, with certain waters, evaporation or an increase in temperature may lead to the precipitation of various minerals on the metal surface. Frequently this is due to the decrease in solubility of some minerals in water with increase in temperature. In other words, when certain waters are heated, some minerals will deposit on the metal surfaces with which the water comes in contact. The most common scale, often found in heating coils such as in water heaters, evaporators, or boilers, consists essentially of calcium carbonate, formed at elevated temperatures by the breakup of calcium bicarbonate.

Since the calcium carbonate that forms is much less soluble than the original calcium bicarbonate, it slowly precipitates and, over a period of time, builds up a white, yellow, brown or gray colored mineral scale on the metal surface. Frequently, when this reaction occurs, considerable stifling of corrosion takes place. Specimens of copper-base alloys have been examined that were so well protected by carbonate or silicate scales ranging from 0.005 in. up to 0.020 in. in thickness that they have resisted corrosion for generations.

Unfortunately, an excessively thick mineral scale on the inside of a water heater coil, boiler or evaporator tube, seriously interferes with heat transfer which results in higher temperatures on the metal surfaces facing the fire or products of combustion. Such conditions may result in failures from rapid oxidation of the metal or actual "burning."

Mineral Scales Formed in Sea Water

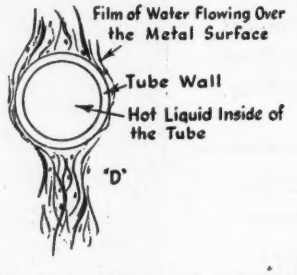
The formation of mineral scales is not limited to fresh water, but is frequently encountered in heat exchangers dealing with the evaporation of sea water as well as fresh water. Here, evaporation leads to the concentration of mineral matter to a point where precipitation occurs, resulting in the formation of thick, flint-like mineral scales on the heating coils. These films, which are generally grey to dark brown in color, may form at rates as high as .0625 inches per month or higher, depending upon the size of coil and the amount of water being evaporated. Steam heated copper coils are widely used for this purpose, and it is frequently necessary to take the coils from the unit in order to remove the layer of mineral matter. If reduction in life of the coil occurs it is due primarily



to the mechanical or chemical means used to remove the mineral scale.

Hot-wall Effect

Sometimes severe local corrosion or pitting can rapidly perforate water heater tubes on the water side because air bubbles separate from the water and cling to the metal surface at certain points, usually at scratches or sharp indentations, thus hindering the water from cooling those spots. The combination of high local temperatures, high concentration of corrosive agent separating where the bubble forms and the quantity of dissolved gas accelerates corrosion at the point of bubble contact. Under these circumstances the rate of perforation of a heater tube increases considerably with an increase in tube wall temperature. Deposits of foreign matter (rust, other types of scales, etc.) may also permit a local high temperature to develop under the deposit. In Figures A and B, the effects of gas bubbles and deposits are shown in heat exchanger tubes where the heat is moving from the outside surface toward the inside surface of the tube. Frequently both the bubbles of gas and deposits of foreign material will separate from the corrosive liquid and result in the condition illustrated in figure C.



Corrosive cooling water passing through a metal tube with only a slightly corrosive hot liquid on the outside may fail prematurely. On the other hand, a tube of the same composition but with the hot liquid passing through the tube and cooling water flowing around the outside of the tube will have a normal life. In this instance the rapidly flowing water prevents both the formation of bubbles of gas and the deposition of certain types of foreign material. See Fig. D.

In laboratory hot-wall tests, non-ferrous and ferrous tubes failed quite rapidly when exposed to 3% sodium chloride solutions. In service, such failures are occasionally encountered on the liquid or water side of the tube. Water heaters with steam or flame on one side of the tubes illustrate the type of equipment where pitting most commonly occurs because of the "hot-wall effect."

The following preventive measures are suggested:

1. The temperature should not be higher than necessary.
2. Continued uninterrupted heating should be avoided.
3. Production of scratches on the metal surface or wiping may shift the point of bubble formation.
4. Gas, sediment, etc. should be removed from the water.
5. Increased water velocity or circulation will help to dislodge bubbles of gas and debris.

Technical Service

A number of condenser tube alloys are available which are designed to resist dezincification, air impingement, pitting and general thinning. If operators are not satisfied with the tube life they are now receiving, our Technical Service Department will submit samples for installation under actual operating conditions. Such tests have brought gratifying results and have led to the installation of condenser tube alloys such as Duronze IV (arsenical aluminum bronze), which have greatly increased the average tube life of seaboard condensers. This alloy is also highly recommended for marine operation. For conditions involving excessive impingement corrosion due to turbulence which cannot be corrected 70-30 cupro nickel has given very satisfactory results.

Condenser Tube Manual

Write for your copy of Bridgeport's 112-page Condenser Tube Manual which contains practical, up-to-date information about tube alloys; specifications; corrosion research data; methods of installing; suggestions for increasing tube life. There are 39 illustrations, 29 diagrams and 23 tables to help present this important information.

Note: Bridgeport products are supplied in accordance with existing priority regulations.

BRIDGEPORT BRASS

BRIDGEPORT BRASS COMPANY, BRIDGEPORT 2, CONN.

BRASS

ESTABLISHED 1865

"LOW STEAM CONSUMPTION MAINTAINED"

reports the city of Corbin, Ky., of their 1500 KW Worthington-Moore Turbine Generator.

GEO. W. JENKINS
Commissioner of Finance

BERT ROWLAND, Mayor

JOHN V. WALKER
Commissioner of Public Works

Power and Water Department
CITY OF CORBIN
H. C. CRAFT, Superintendent
Corbin, Kentucky

Worthington Pump and Machinery Corporation
Eight and Race Streets
Cincinnati 1, Ohio

Dear Sirs:

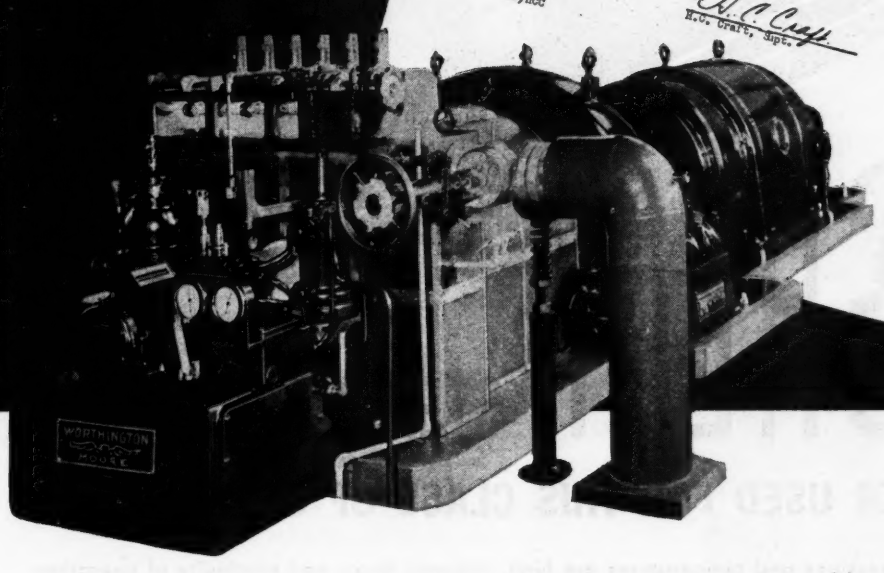
Attention-Mr Earle W. Vinnedge
Manager
Cincinnati District Office

You will recall that when our 1500 KW turbine generator unit which we purchased from Worthington was installed 4½ years ago it was necessary for us to immediately put it in service due to load demands without the usual tune up period. Since then the unit has been in practically continuous service and now that we are in a position to do so we have decided to open the turbine for inspection.

We believe that you will be interested to know that except for routine adjustments maintenance has been negligible and the original low steam consumption has been maintained. We are very pleased with the service and economical operation this unit has given us and the interest you have shown.

Yours very truly,
CITY OF CORBIN
POWER and WATER DEPT.
H.C. Craft, Supt.

HC/hcc

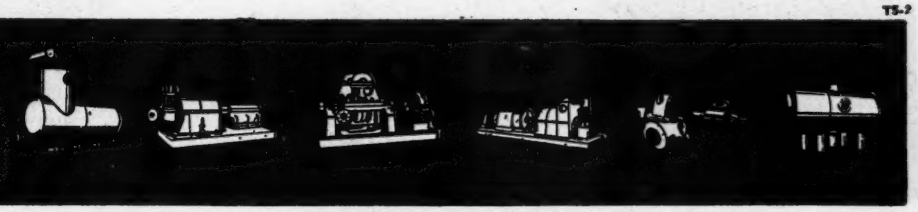


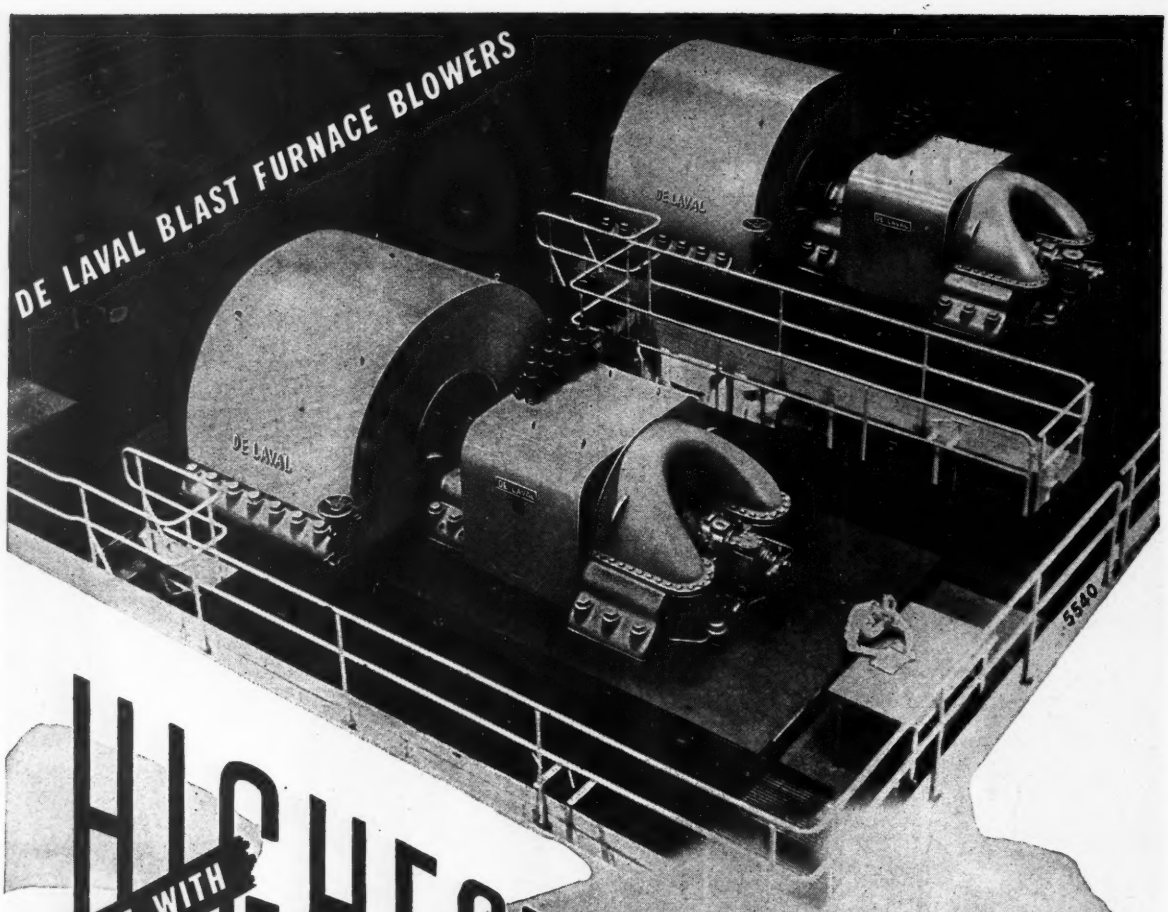
Low maintained steam consumption, freedom from operating troubles and the ability to be placed in continuous service immediately after erection without a "tune-up" period are typical characteristics of all Worthington Turbine Generator units. This is made possible by our practice of testing the complete unit under operating steam conditions and load at our works before shipment . . . Write today for Bulletin 1960 . . . further proof that *there's more worth in Worthington. Worthington Pump and Machinery Corporation,* Moore Steam Turbine Division, Wellsville, N. Y.

WORTHINGTON

A GREAT TEAM IN STEAM

TS-7





OPERATE WITH HIGHEST STEAM PRESSURES

EVER USED FOR THIS CLASS OF SERVICE

Where steam pressures and temperatures are high, volumes large, and continuity of operation imperative, De Laval blast furnace blowers meet the challenge.

Among the many notable De Laval installations are two turbine-driven blowers employing the highest steam pressures and temperatures ever used in the United States for this class of service. These units are installed at the Edgar Thomson Works of the Carnegie-Illinois Steel Corp. Designed for steam at a maximum pressure of 700 psig and 825 F., they operate under conditions comparable to those employed for modern power generating units. The blowers have a capacity of 97,800 c.f.m. against 30 psig.

Our engineers will be glad to study your blower and compressor requirements.

3831

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS CENTRIFUGAL PUMPS • CENTRIFUGAL BLOWERS and COMPRESSORS • IMO OIL PUMPS

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STEAM TURBINE COMPANY · TRENTON 2, NEW JERSEY

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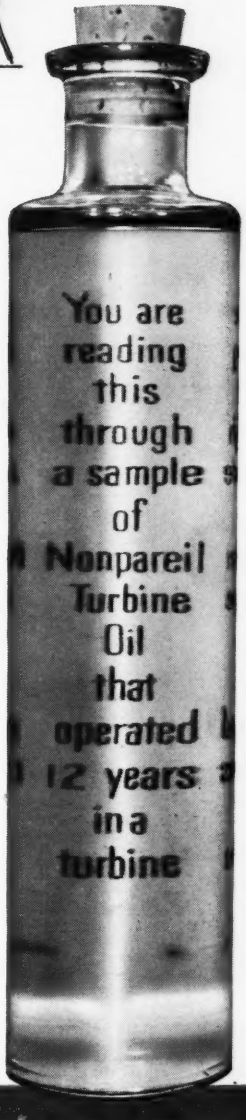
There is a message for you in this turbine oil sample

A life-size unretouched photograph



NONPAREIL
TURBINE OIL

Of course, the picture doesn't tell the whole story, so here are the facts.

The sample illustrated is from a fill of oil installed in a 5000 kw. turbine, June, 1933. Since then, the turbine has operated regularly, yet this fill of oil—

- has never been removed from the turbine oil system for treating or resting.
- has only been filtered through a bag-type filter.
- has shown no sign of rust or corrosion.
- has Tag-Robinson color of 16.
- has the extremely low neutralization number of .04 mg. KOH/gm.
- has an indefinite period of the same clean, acid-free operation ahead—it is guaranteed for the life of the turbine.

Compare this record with the time, trouble and expense of maintaining a fill of oil for 12 years in your plant. Compare also the years of guaranteed satisfaction still available in this fill of Nonpareil Turbine Oil. Wouldn't it pay you to change to Nonpareil Turbine Oil now?

A Standard Oil Lubrication Engineer will be glad to answer any questions you have about Nonpareil Turbine Oil. Call the local Standard Oil Company (Indiana) office, or write 910 South Michigan Avenue, Chicago 80, Illinois.

Buy more War Bonds

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

★LUBRICATION ENGINEERING

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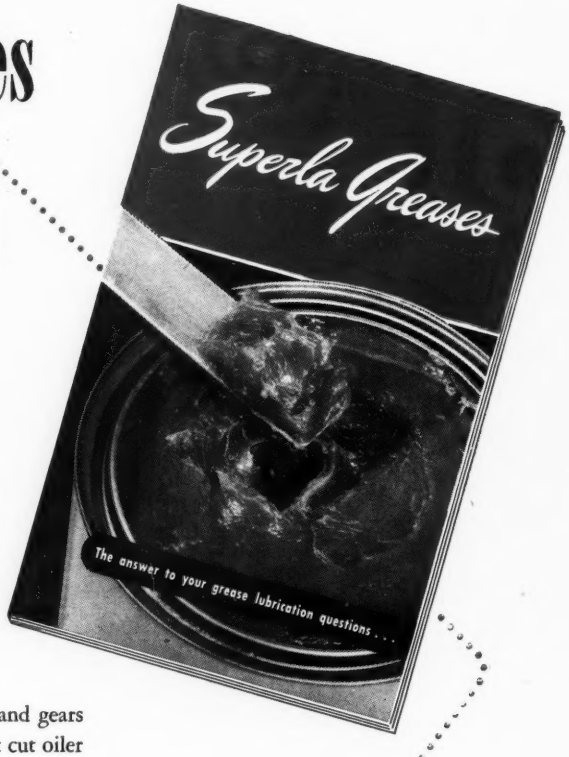
What qualities to look for in cost-saving greases



QUALITIES that reduce wear on bearings and gears . . . that stop excessive consumption . . . that cut oiler time for servicing equipment . . . these are the qualities you want in a grease. What they are and how you can get them is described in a booklet illustrated at right.

Many of the advantages, which you would expect to find only in special purpose, premium priced greases, are available in a line of 11 grades—including high-temperature greases—called

SUPERLA GREASES

Send for this Booklet

It tells how the most desirable qualities have been incorporated in a complete line of grease to reduce costs on a wide range of Industrial application.

It also has hints on hand packing anti-friction bearings and avoiding over-lubrication.

You can get a copy from the Standard Oil Industrial Service Representative who calls on you or by writing Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

Buy more War Bonds

STANDARD OIL COMPANY (INDIANA)

STANDARD SERVICE

★ LUBRICATION ENGINEERING

YESTERDAY HE SENT HIM OUT FOR GASKETS AND HE ASKED WHERE THE FUNERAL WAS
GET THAT OUT OF HERE BEFORE I GO NUTS. I WANT TO PACK A FLANGE NOT A SET OF DISHES!
IF HE SENT HIM FOR A WRENCH HE'D COME BACK WITH A STRAINED BACK
PULLING A PACKING BONER IS A SURE FIRE WAY TO GET THE BOSS STEAMED UP
YOU SENT ME FOR PACKING BOSS AND THIS LOOKS LIKE PACKING TO ME
PICK RAINBOW AND STAY OUT OF TROUBLE
WHEN HE GOES BACK FOR THE PACKING HE'D BETTER BRING RAINBOW OR THE BOSS WILL MAKE HIM SEE STARS

IT *stays* PACKED WITH RAINBOW

For 56 years Rainbow has been the packing that will not squeeze or blow out in service. Whenever you pack a flange or parallel surface with this original Red Sheet Packing, it *stays* packed.

Rainbow, the original Red Sheet, is designed for packing against hot or cold water, air, saturated steam pressures up to 150 pounds, and all hydraulic conditions. It fills up every irregularity in the flange.

Serving Through Science with Mechanical Packings for All Industry

UNITED STATES RUBBER COMPANY

Serving Through Science

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"On the line" 94.3%

Average Record of

This 3-year record of 5 C-E Steam Generating Units operating under war-time service demands in four large utility plants testifies to the kind of stay-on-the-line performance that is the primary objective of C-E design.

CUMBERLAND STATION

THE POTOMAC EDISION CO.
CUMBERLAND, MD.

•

Capacity—312,500 lb of steam per hr
Design Pressure—925 psi
Total Steam Temp.— 830 F

UNSCHEDULED OUTAGE
1.06% IN 3 YEARS

USE FACTOR
98.2%

WESTPORT STATION
2 UNITS

CONSOLIDATED GAS, ELECTRIC LIGHT & POWER COMPANY OF BALTIMORE
BALTIMORE, MD.

•

Capacity—285,000 lb of steam per hr (each)
Design Pressure—1450 psi
Total Steam Temp.—915 F

UNSCHEDULED OUTAGE
1.28% (Unit No. 1)
IN 3 YEARS

UNSCHEDULED OUTAGE
1.0% (Unit No. 2)
IN 3 YEARS

USE FACTOR
92.5%
AVERAGE BOTH UNITS

of the time for 3 years

5 C-E Steam Generating Units in 4 Plants

LOGAN STATION
APPALACHIAN ELEC. POWER CO.
LOGAN, W. VA.

•

Capacity—1,000,000 lb of steam per hr
Design Pressure—1425 psi
Total Seam Temp.—925 F

UNSCHEDULED OUTAGE
1.8% IN 3 YEARS

USE FACTOR
93.6%

MANCHESTER STREET STATION
NARRAGANSETT ELECTRIC CO.
PROVIDENCE, R. I.

•

Capacity—430,000 lb of steam per hr
Design Pressure—1350 psi
Total Steam Temp.—915 F

UNSCHEDULED OUTAGE
0.98% IN 3 YEARS

USE FACTOR
93%

ll of these service records have been eviously presented in graph form, howing when the outages occurred and hy. They should be interesting mate- al for the perusal of any utility engi- eer. If you missed them when they ppeared as individual advertisements uring the past few months, we shall e glad to send you a complete set.

C-E

COMBUSTION ENGINEERING

00 MADISON AVENUE ◉ NEW YORK 16, N. Y.

BULLETIN!

How to Take a Reconversion Inventory of Your V-Belt Drives

☛ As manufacturing equipment becomes more widely available, and as you reconvert your production toward a peacetime basis, you may be faced with an unprecedented problem of inventory-taking.

☛ You may have to determine—more quickly than such a job has ever been done before—the EXACT CONDITION of every piece of existing equipment that you propose to use in peacetime production.

☛ Here are suggestions to speed your inventory of V-belt drives. The standards stated here will let you determine which of your *belt sets:* (1) are okay as is; (2) will shortly require replacement; (3) need immediate replacement. You should be able to place *sheaves* in the same categories, or in a fourth: (4) are obsolete . . . a common failing of sheaves, now that "Magic-Grip" and Vari-Pitch Sheaves are becoming more readily available. Or you may decide that entire *drives* belong in a fifth classification: (5) need re-engineering . . . either to correct misapplications forced by wartime shortages, or to take advantage of new developments such as Allis-Chalmers' Variable Speed Drives, with either Stationary or Motion Control.

1 START YOUR INVENTORY WITH THE RECORDS

Your records will reveal much that will be of value to you in appraising your present multiple V-belt drive equipment and in establishing its place in reconverted production.

Purchase records should show which drives have required new belts too frequently. While there's no overall rule to tell you how long a belt should last, it's safe to assume that *whenever you spot a drive* whose belts wear out *much* more rapidly than all the others, *you've found a place* where a change will save you money.

Maintenance records and *machine operating records* will reveal useful facts. Is a machine often down while belts are replaced? While sheaves are changed? Then there's room for improvement. Check trouble spots *first.* You can spot these trouble spots if you'll *start with the records.*

2 THEN CHECK DRIVE ENGINEERING

V-belt wear will be excessive — too costly for competitive peace-time operation — unless the drive is tailored to its particular power transmission job in the following respects:

Diameters—Depending on the thickness of its section, every V-belt has an "easy arc". Bend it more sharply (around a sheave of too small diameter) and the internal friction of excess flexing will cook the life out in far too short a time. In general, minimum sheave diameters for belts of given section are as follows: A—3.0"; B—5.4"; C—9.0"; D—13.0"; E—21.6".

Centers—The shorter the centers in a drive, the fewer feet of belt that can stretch—the lower the potential stretch to threaten slippage and crack-the-whip action. Thus proper engineering aims at short centers. (Short centers have the further advantage of saving valuable floor space . . . an important consideration in many factories.) In every reapplication of V-belt drives for reconverted production, remember . . . *keep centers as short as possible.*

Number and size of belts — Each V-belt is rated for horsepower; simple mathematics will tell you how many of what size you'll need for a given job. When reconverting, it's wise to *check this again* . . . the war has produced many undesirable makeshifts. Remember, though, that number and size don't tell the whole story—*speed counts too.*

Belt speed—Just as a truck's motor can pull a heavier load by traveling faster, so a set of V-belts can pull a heavier load by traveling faster. In a truck, it's a case of using a "lower" gear. In a V-belt drive, it's the same . . . using larger sheaves which have a higher rate of rim travel, thus producing higher belt speed. See the V-belt manufacturer's catalog for limits of speed recommended for any given belt.

Contact arcs—All horsepower ratings for V-belts are based on a 180 degree arc of contact with sheaves. However, this factor varies from one drive to the next—depending on its ratio and centers—and must be carefully considered in re-engineering any drive.

Tension—Each drive should be equipped with an effective tension adjustment. Belts that are too loose will slip, rub on the groove walls, heat up, and have the life cooked out of them. And when the wave curve in a loose belt whips it *tauter* across the tension

side of the drive—that belt grabs at the load, may snap. So—in checking V-belt drives for reconverted production, it's important to see to it that each set of belts has proper tension. The easiest and quickest rule-of-thumb test for proper tension is this: "A slack V-belt feels dead when you thump it with your hand; a properly taut V-belt has an alive springiness."

Alignment—Unless the shafts of the driving and driven sheaves are *parallel,* it's impossible to put *all* belts in the set at proper tension . . . and all belts run at an angle, rubbing on the groove walls, heating themselves for an early death. In reconverting for a competitive production, check parallelism of shafts . . . and check too to see that *sheave grooves* are *in line.* Out-of-line sheaves also subject belts to needless rubbing on the groove walls.

If any of your V-belt drives is notably weak in any of the above seven points, consider re-enginering the drive.

3 THEN INSPECT V-BELTS

Your inventory of working V-belts will reveal far more than just their condition; it will also show what should be done to correct existing conditions that promote V-belt wear—an important consideration in cost-conscious, competitive production. Check every belt in every set for the following tell-tale signs; note condition of belt, cause, and recommend cure.

Checking these points is especially important if you're planning a *continuous* operation where belt breakage would be fatal. You can spot about-to-break belts by looking for:

SCUFFING—*Cause*: Bolts protruding inside the guard may do this. Such scuffing can exert enough "braking" to cause sudden snap and break belt.

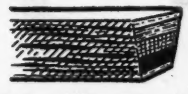
Cure: When placing guards or steelwork near drives, anticipate some sag . . . leave enough clearance.

SLIP BURN—*Cause*: Belt too loose to pull its load. Belt stands still, rubbing on spinning driving sheave, heating and melting the rubber.

Cure: Keep belt taut, and sheave grooves free of oil and grease. Check machine for overload.

OIL-SWELLING *Cause*: Belt is is swelled and weakened by chemical action of oil.

Cure: Provide splash guards, or use Oil-Resisting or Oil-Proof Texrope Belts.



ABRASION—*Cause*: Abrasive dust wears the sidewalls, narrowing belt width. Then belt slips, rides on bottom of groove.

Cure: Provide dust guards, keep proper tension.

4 CHECK BELT ENGINEERING

Because Allis-Chalmers belt development during wartime followed the familiar pattern of many industrial achievements—moving swiftly and outmoding many previously-acceptable types—it is *not* wise policy to replace belts by blindly ordering the same kind used in the old installation. Belts have become specialized for better economy, safety and dependability. It is time now to take a look at qualities of the new belts, and to take advantage of the special properties they have been given through use of new synthetics in their manufacture.

NOTE: THE MATCHED-SET PRINCIPLE—When one or two V-belts in a set are worn out or damaged, remember that the remaining V-belts have stretched beyond their original length, making it impossible to put proper tension on an old set to which *new* belts have been added. Adding new belts is therefore likely to be false economy . . . the new belts will overwork, lasting for only a fraction of their normal life. Rather than throw good money after bad, always install a complete, scientifically-matched set, storing old belts to use as replacements in other old sets.

5 INSPECT SHEAVE WALLS

For smoothness—What makes a V-belt grip the sheave? Not mere surface friction, but the *wedging* action of the bending and expanding belt. So sheave grooves may be smooth . . . *should* be smooth, to minimize belt wear. Watch out for ridges or burrs in the groove walls; if they're bad, re-groove or replace the sheave. Increased belt life will soon pay the cost.

For straightness—The sides of the V should be *straight;* if they're not, drive won't be truly efficient, belt life will be short. Some sheaves—misaligned or in hard usage—get "shoulder wear" in groove walls. Lay a straight-edge against the wall, look for a light gap. If you find hollows deeper than the thickness of a playing card, sheave needs truing.

REPLACE? OR REGROOVE? You'll have to make this decision. Note this: where small, inexpensive stock size sheaves show need for re-truing of grooves, time and trouble can often be saved by scrapping them and replacing with new sheaves. It may pay out, however, to re-groove special or large-diameter sheaves, or to return them to the factory, where a nominal charge is made for this service.

RECONVERSION INVENTORY CHECK LIST FOR V-BELT DRIVES

Ask A-C for sample copies of this V-Belt Drive Inventory Check List.

CENTRIFUGAL PUMPS, ELECTRIC MOTORS NEED INVENTORY TOO!

All three of these common industrial units — V-belt drives, centrifugal pumps, and electric motors — are covered in Allis-Chalmers' new *Reconversion Inventory Kit.* No big package, this Kit is simply a set of Fact Sheets and Check Lists, with suggestions for Inventory procedure as outlined on these pages but in slightly more detail. A 1884

GET THESE FREE FORMS!

For your supply of Reconversion Inventory Kits, covering V-belt drives, centrifugal pumps, and motors, call your nearest Allis-Chalmers district office or distributor, or write Department 110, ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WIS.

ALLIS CHALMERS

TURN TO TYCOL "Engineered

ENGINEERED SOLUTIONS TO YOUR LUBRICATION PROBLEMS *at your fingertips*

Tycol lubricants are made in a comprehensive line to meet each specific service requirement. Their performance-proved lubricating ability is the result of modern scientific engineering and rigid testing. The line includes:

DIESEL OILS of 100% paraffine base, refined by the most modern processes to eliminate unstable compounds that would oxidize in service. There is a Tide Water Associated Oil for every Diesel requirement.

TURBINE OILS with great stability and resistance to emulsification . . . free from sludge-forming hydrocarbons . . . engineered to inhibit Rust.

CYLINDER OILS refined from 100% Pennsylvania Crude. They have exceptionally high resistance to breakdown under high temperature operation.

SPECIALIZED INDUSTRIAL LUBRICANTS for all types of machinery in all types of industry — from steel to textile.

GREEN CAST GREASES, made from paraffine base cylinder oil with a minimum of soap . . . extremely economical, giving greater lubrication per pound than do conventional greases.

VEEDOL MOTOR OIL, refined from 100% Pennsylvania Crude by Tide Water Associated's triple-refining process, which produces that tough "film of protection" — famous all over the world.

Any Tide Water Associate office will help you select the oil or grease best suited to your needs.

Drums! Drums! Drums!

War needs make it imperative that all empty drums be returned immediately.

TYCOL INDUSTRIAL

ENGINEERED FOR EVERY

Lubrication"

FOR GREATER SERVICE...LONGER LIFE

from *everything* that *TURNS!*

All equipment will last longer — give better service — if the proper lubricant is used. That's why you will find it profitable to use Tycol oils and greases.

There's a reason! No matter what your lubricating need — extreme pressure*, high or low temperature, high speed, or any other service condition — there's a Tycol Oil or Grease scientifically engineered exactly to suit your specific requirements.

Refined from the highest grade crudes, Tycol lubricants are exceptionally resistant to breakdown which means greater economy . . . longer machine life for every type of equipment.

Tide Water Associated engineers will gladly recommend the Tycol lubricant that meets your particular requirements. Call, write or wire your nearest Tide Water Associated office today.

Makers of the Famous VEEDOL Motor Oil

***EXTREME PRESSURE!** For clear, concise descriptions of the basic tests used to determine important lubricant properties — Viscosity, Pour Point, Extreme Pressure and many others — consult Tide Water Associated's informative handbook "Lubricania". For your FREE copy write: Tide Water Associated Oil Company, 17 Battery Place, New York 4, N. Y.

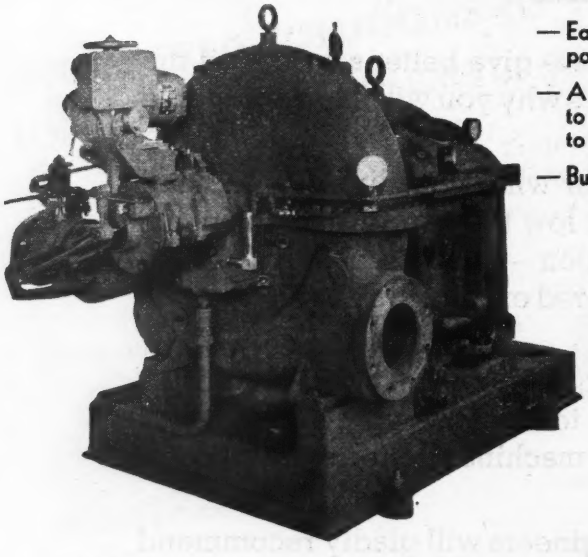
LUBRICANTS
SERVICE NEED

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N. Y.

PRINCIPAL OFFICES

The TERRY

—IS BUILT IN A WIDE RANGE O SIZES FOR ALL MECHANICAL DRIV APPLICATIONS



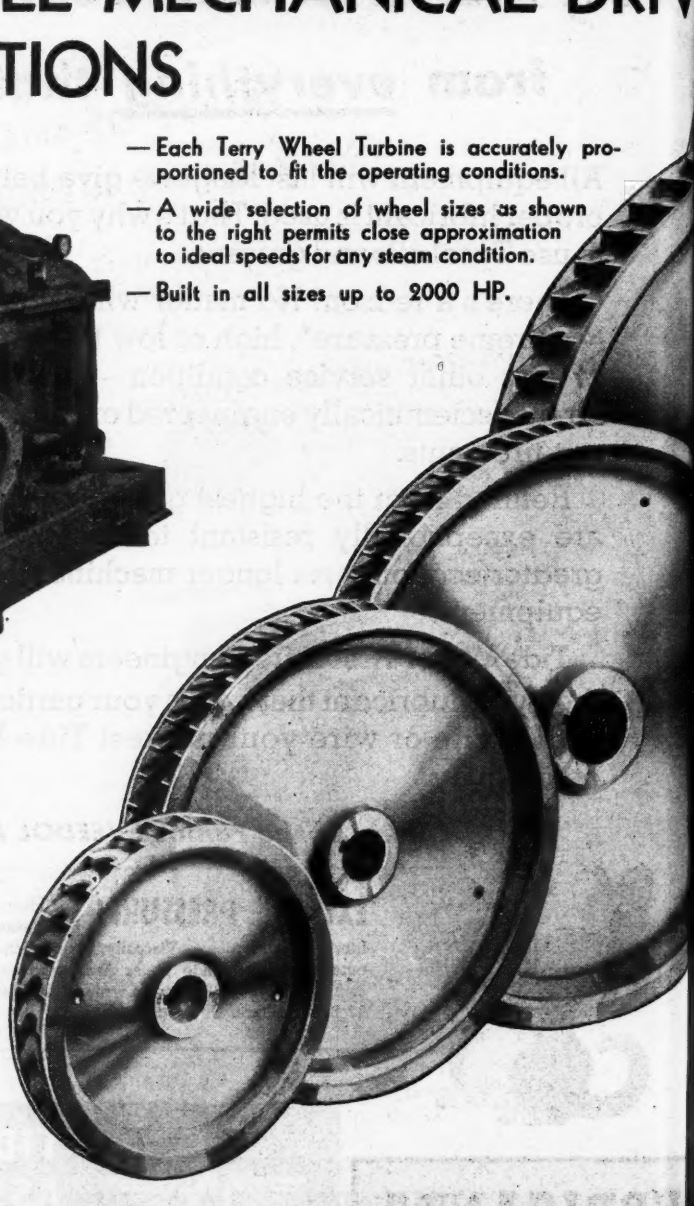
— Each Terry Wheel Turbine is accurately proportioned to fit the operating conditions.

— A wide selection of wheel sizes as shown to the right permits close approximation to ideal speeds for any steam condition.

— Built in all sizes up to 2000 HP.

ABOVE:

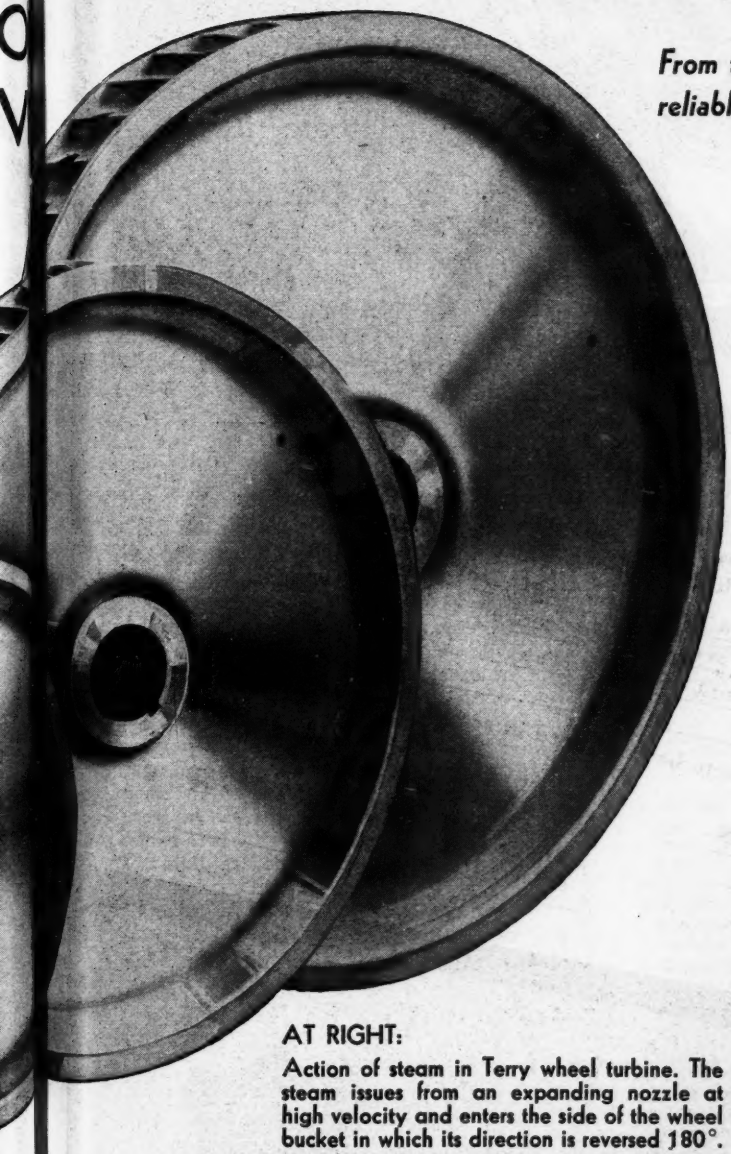
Typical Terry Solid Wheel Turbo-Gear Unit. Rated 160 HP at 4000 to 1720 RPM with steam conditions of 400 lbs., 750°F.TT, 30 lbs. Used for Blower Drive.



FOR FULL DETAILS ASK FOR BULLETIN S-116

THE TERRY STEAM TURBINE CO.

Wheel Turbine



From the smallest to the largest these reliable turbines have—

- ★ Indestructible one piece wheel.
- ★ Large radial and axial clearances.
- ★ Double rim protected blading.
- ★ Individual nozzle control.
- ★ Dependable and durable governor.
- ★ Heavy dust-proof bearing and governor housing.
- ★ Independent overspeed trip with separate valve.
- ★ Sturdy casing design.
- ★ Strong and easily inspected steam strainer.
- ★ Truly accessible construction, which makes inspection of the interior parts a simple matter.

AT RIGHT:

Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

T-1139

TERRY SQUARE - HARTFORD, CONN.

Enough Said!

SIMPLEX VALVE & METER COMPANY
CHICAGO 4, ILL.

We desire to have the services of the Simplex Service Engineer in connection with the following Simplex apparatus

Much though we enjoy the visits of your service engineer, at present your damned old equipment is working so well we don't feel we can justify the expense.

This service to be performed in accordance with the notice sent us.

DATE [redacted]

SIGNED [redacted]

ADDRESS [redacted]

*Name furnished on request.

SIMPLEX VALVE & METER CO.
6783 UPLAND STREET, PHILADELPHIA 42, PA.

One of a series of advertisements, each discussing trapping practice on a different class of equipment.

HOW TO TRAP STEAM JACKETED EQUIPMENT for faster heating

User Reports 75% Reduction in Cooking Time

Correct drainage of condensate from steam jacketed kettles, vats, cylinders, pans and similar equipment can save time and save steam. The table below contrasts proper trapping with drainage through a cracked valve. This is substantiated by other reports: a Chicago firm reduced cooking time on kettles 75%—from 40 minutes to 10 minutes; a California packing company reduced average cooking time from 27 to 17 minutes; other companies report similar benefits.

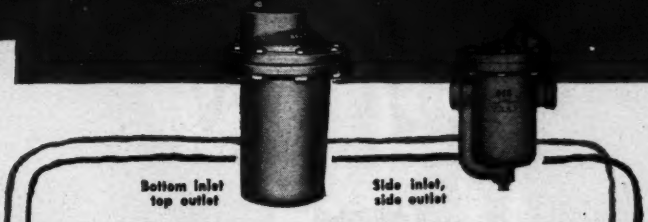
The reasons for these results are two:

1. Armstrong Trap design — no steam leakage, big air venting capacity, ability to discharge condensate as fast as it accumulates regardless of temperature.

2. Armstrong recommendations — covering trap selection and installation practice. Based on tests and experience on thousands of installations.

Armstrong traps are sold through leading distributors everywhere on a basis of "satisfaction *guaranteed*". For better trapping, write to

Armstrong Machine Works
810 Maple St., Three Rivers, Mich.



Some Tips Regarding Drainage of Steam Jacketed Equipment*

- Use one trap for each unit.
- Install trap close to and below unit.
- Use ample size steam supply lines.
- Size return lines to prevent excessive back pressures.
- For *fast* heating use an Armstrong trap with extra air handling capacity.
- For *medium speed* heating use standard Armstrong trap.
- For *slow* cooking use smaller size trap.

* Complete data with engineering charts and tables given on page 29 of the *Armstrong Steam Trap Book*. Ask for a copy.

Table showing cost of various sized steam leaks at 100 pound pressure (assuming steam costs 50 cents per 1000 lbs.)

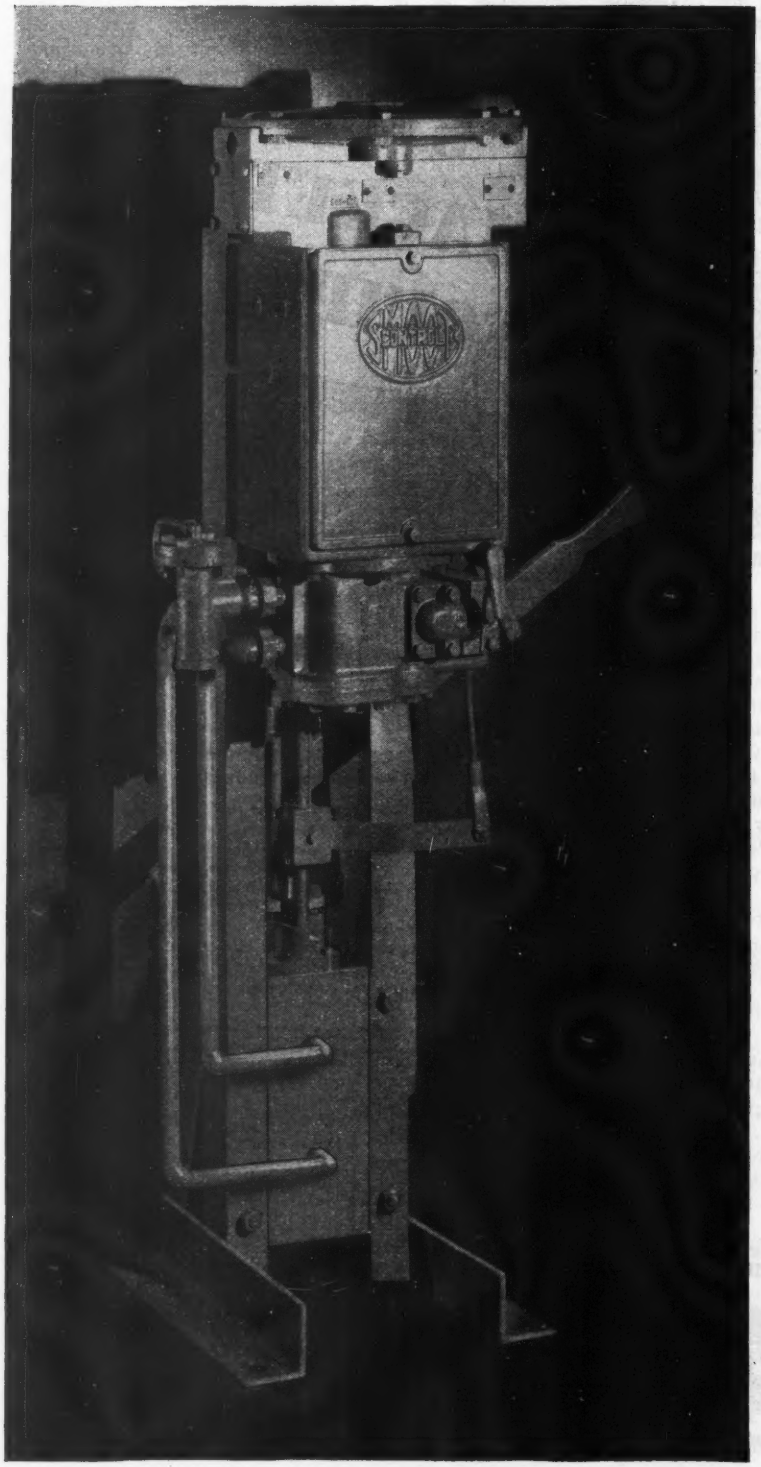
Size of Orifice	Lb. Steam Wasted Per Month	Total Cost Per Month	Total Cost Per Year
1/2"	835,000	$417.50	$5,010.00
1/4"	210,000	105.00	1,260.00
1/16"	13,200	6.60	79.20
1/32"	3,400	1.70	20.40

(For steam at 50 lbs. pressure, the waste is about 75% of the above figures: at 20 lbs., it is about 50%; and at lbs., the loss is about 25%.)

ARMSTRONG Inverted Bucket STEAM TRAPS

Over a Million in Use...For Power...Process...Heating

The Trend is to...



REPUBLIC REGULATOR APPLICATIONS

Pressure Control

Steam pressure control
Boiler furnace draft
Primary air pressure
Feed water pressure
Evaporator pressure
Process steam pressure
Blast air pressure
Exhauster suction
Fuel gas pressure
Suction main pressure
Excess pressure

Flow Control

Water flow to desuperheaters
Water flow to condensers
Oil flow to boilers and furnaces
Gas flow to boilers and furnaces
Air flow to gas producers
Pump bypass

Level Control

Hot well levels
Surge tank levels
Storage tank levels
Evaporator levels
Boiler water levels

Speed Control

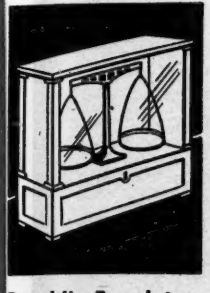
Stoker and fuel feeder speeds
Pulverizer speed
Pump speed
Fan speed
Steam turbine speed
Steam engine speed
Variable speed motors
Variable speed transmissions

View of a Republic hydraulic type regulator for controlling boiler air flow, mounted on stand with power cylinder.

REPUBLIC
INSTRUMENTS
AND CONTROLS

REPUBLIC Regulators

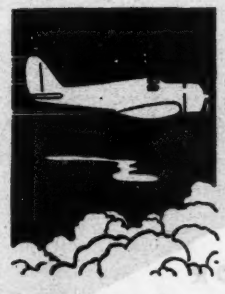
Because They Meet These Four Essentials of Good Regulation



Republic Regulators can be made sensitive to changes of less than 0.002 of an inch of water.

SENSITIVITY

The amount of change that is required in the quantity being controlled to effect the regulator is the measure of its sensitivity. For close, accurate regulation, a regulator must be sensitive. It must respond immediately to the slightest deviation from the predetermined setting or the controlled quantity may vary far beyond the permissible limits.



Republic Regulators will meet any speed requirement up to one full stroke in 2 seconds.

SPEED

The speed at which a regulator operates is an important factor in any control system. Any time lag between the variations in the controlled quantity and the operation of the control device to correct this variation, will produce an unnecessary error in regulation. A regulator, therefore, must be fast enough to follow the fastest load fluctuation.

Republic power cylinders are available to meet the specific power requirements of any particular installation.

POWER

A regulator must have sufficient power to not only operate the valve or other control device, but also to overcome any accidental friction or sticking that may occur in any part of the system. Insufficient power will cause failure in operation. It is for this reason that regulators are made with different size power cylinders, the smaller sizes being used for small valves and the larger sizes for the larger dampers and louvers.

The Republic stabilizer will stabilize against any time lag in the operation of the equipment being controlled.

STABILITY

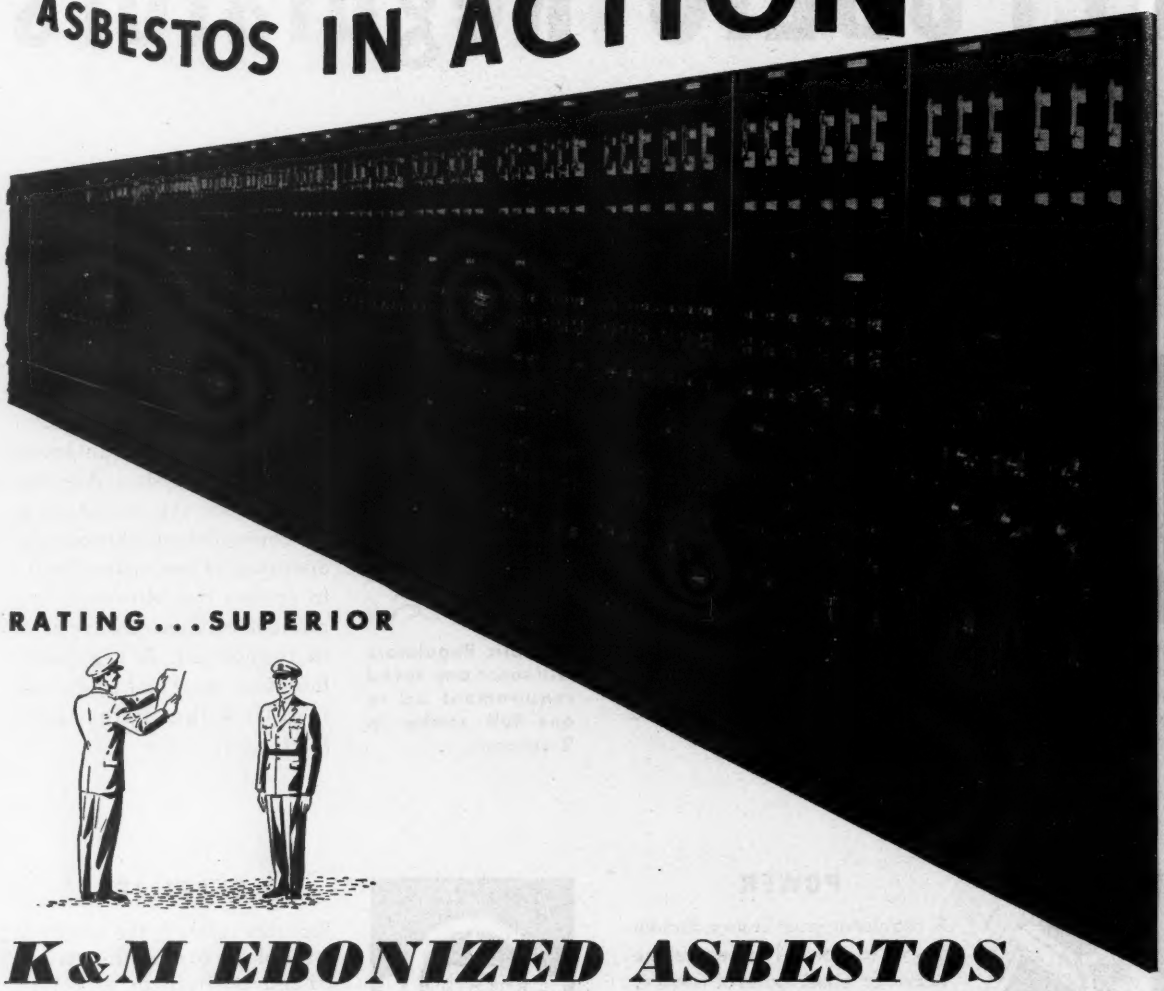
Stability refers to the ability of a regulator to maintain its balanced position or to return immediately to a balanced position if the controlled quantity is disturbed. There is always an interval between the time the valve or other control device is moved and the time the controlled quantity changes in response to this movement. Unless a regulator is stabilized it will tend to "hunt" or overtravel causing unnecessary variations.

Write for Data Book No. S-13

Republic Flow Meters Co.

2224 Diversey Parkway • Chicago 47, Illinois

ASBESTOS IN ACTION



RATING...SUPERIOR

K&M EBONIZED ASBESTOS

• For unfailing performance in action, in spite of severe shock and vibrations . . . for unusual ability to resist oil and moisture . . . for high dielectric strength, progressive electrical engineers rate K&M Ebonized Asbestos as *superior*.

K&M Ebonized Asbestos mounting material is not affected by rapid changes in temperature, nor will it crack, shrink or bulge. It is made of a combination of asbestos fibre, binding cement and insulating compound, molded under terrific pressure into strong monolithic sheets. It is uniform in density. It comes in standard or special "panel" finish . . . from $\frac{1}{8}$" to 4 inches thick.

Not only does K&M Ebonized Asbestos meet exacting requirements for electrical switchboards, but it is also ideal for bus bar runs, testing tables, cabinets, bench boards, compartment linings and many other types of electrical installations.

Ebonized Asbestos is specially developed to meet the technical requirements of Underwriters Laboratories, Inc. when built into an assembled unit. Nature made Asbestos...Keasbey & Mattison has been making it serve mankind since 1873.

Photo
Courtesy Frank Adam Electric Co.
St. Louis, Mo.

KEASBEY & MATTISON

COMPANY • AMBLER • PENNSYLVANIA

PREVENT RUST and SLUDGE in your turbines

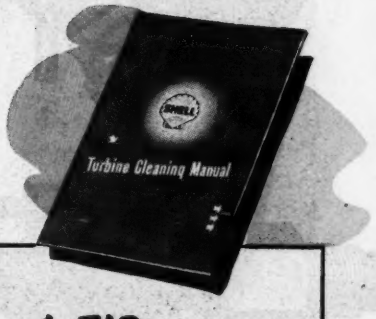
SHELL TURBO OIL IS FORTIFIED to prevent turbine rust and sludge.

Here's the first turbine lubricating oil to actually prevent sludging and rust.

Especially fortified, this oil provides unusual oxidation stability, which prevents the formation of sludge, prevents emulsion-forming products—makes the oil last longer.

Moreover, Shell Turbo Oil stops rust by adhering closely to the metal surfaces, keeping air and water away. And it does not foam.

You'll be surprised at the economy of Shell Turbo Oil . . . To get the facts, contact Shell Oil Company, Incorporated, 50 West 50th Street, New York 20, New York; or 100 Bush Street, San Francisco 6, California.



A TIP...

Before changing over to Shell Turbo Oil, give your system a thorough cleaning. You'll get even finer results and save money in the long run. The booklet above describes this quick, easy operation. Send for your complimentary copy.

SHELL TURBO OIL

Specify ERNST SAFETY WATER COLUMNS
FOR *Better* VISIBILITY

ON LAND

AND SEA

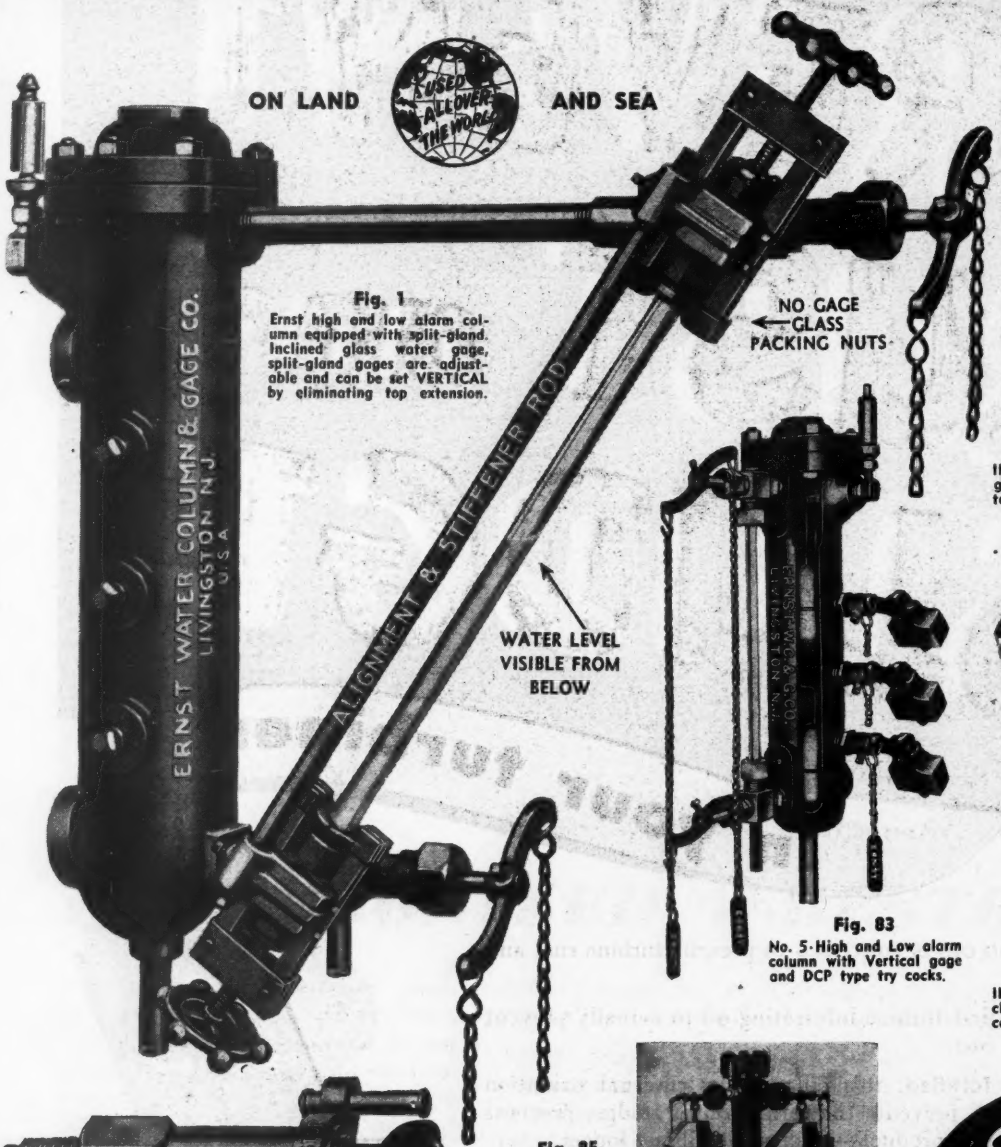


Fig. 1
Ernst high and low alarm column equipped with split-gland. Inclined glass water gage, split-gland gages are adjustable and can be set VERTICAL by eliminating top extension.

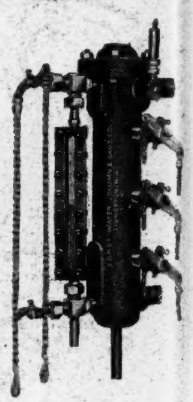


Fig. 30
Illustrates Vertical prismatic wa gage. Steam shows WHITE and w ter shows BLACK.

Fig. 83
No. 5-High and Low alarm column with Vertical gage and DCP type try cocks.

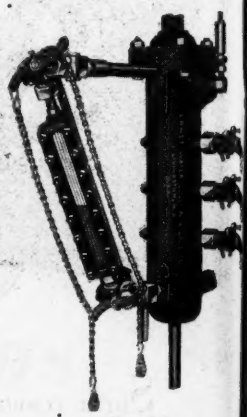


Fig. 32
Illustrates Standard Adjustable clined prismatic gage attached column, also super leakless try co

Fig. 13
LEAKLESS COCKS, Bronze and Forged steel construction.

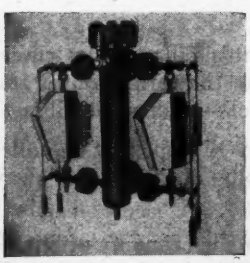


Fig. 85
Ernst Two-Gage High and Low alarm column with direct Vision Hoods and C-Clear thru Inserts for pressures up to 900 pounds.

Ernst
STANDARD COLUMNS FOR PRESSURES UP TO 900 LBS

SPECIAL COLUMNS FOR HIGHER PRESSURES

— FOR REPLACEMENTS ORDER —

High Pressure
GAGE GLASSES
Flat, round, and reflex type . . . . also mica shields

RUBBER GASKETS
High Pressure supplied in all sizes

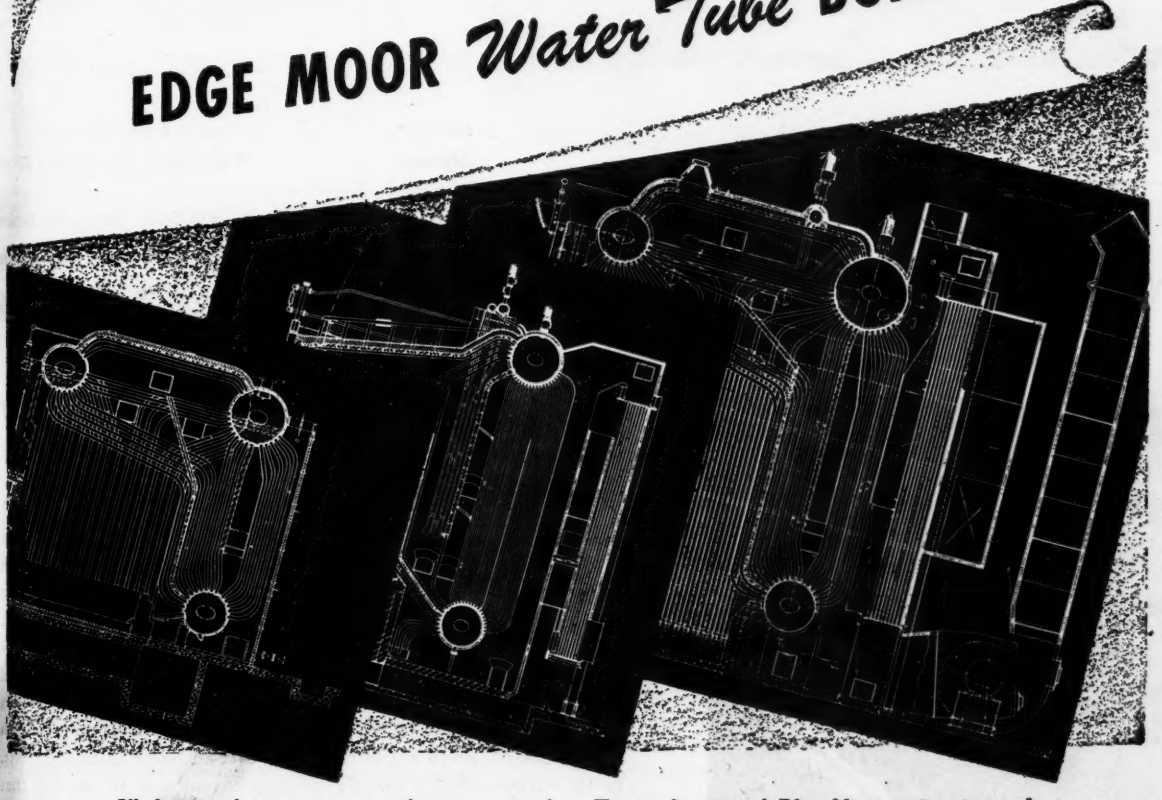
Shipments from stock

Send for Descriptive Bulletin

Ernst **WATER COLUMN & GAGE CO.**
Tel. Livingston 6-1400

250 S. LIVINGSTON AVENU
LIVINGSTON, NEW JERSEY

EDGE MOOR *Water Tube* BOILERS



All designs of steam generators for any required capacity and up to 900 lbs. drum pressure are completely engineered and built at Edge Moor.

The combination of Edge Moor engineering and manufacturing control insures the ultimate in modern power plant construction.

STEAM GENERATING EQUIPMENT

EDGE MOOR
IRON WORKS, INC.

BRANCH OFFICES: **NEW YORK 20, N. Y.: 30 ROCKEFELLER PLAZA**
CHICAGO 2, ILL.: ONE NORTH LA SALLE STREET

MAIN OFFICE: **EDGE MOOR, DELAWARE**

COMPARE THESE RECORDS

In 1941 the Kieckhefer Container Co., Delair, N. J., installed an Iron Fireman Pneumatic Spreader Stoker in a boiler which has been fired for several years by another type of stoker. The comparative record is shown below:

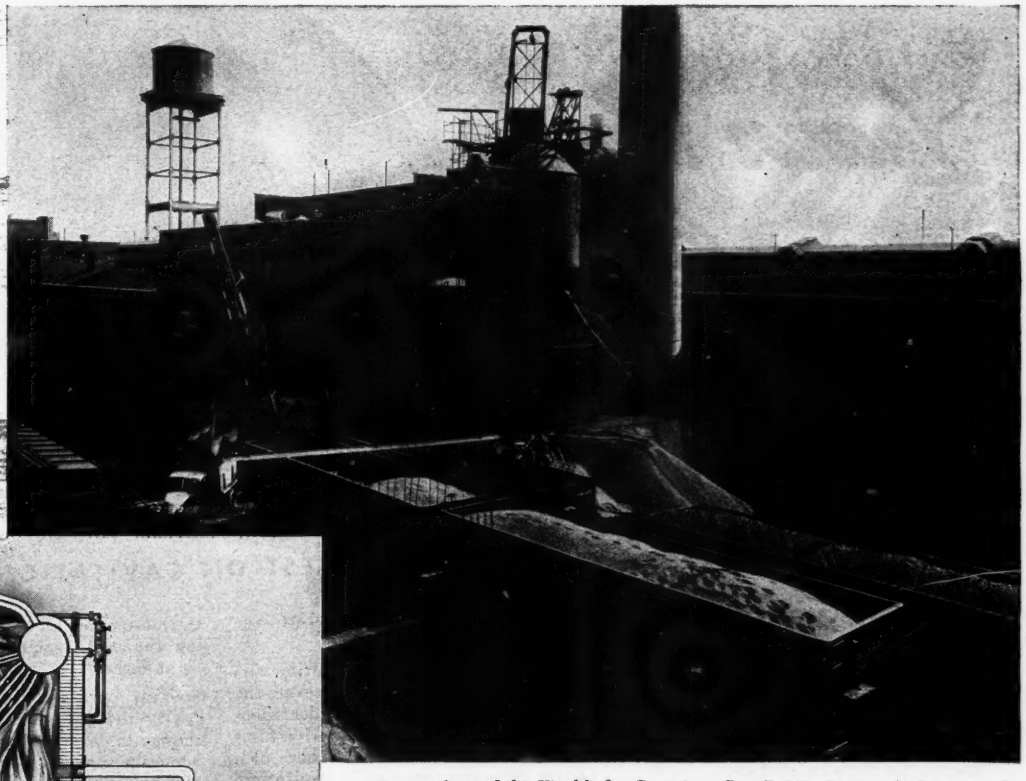
		Former Stoker	*Iron Fireman Pneumatic Spreader Stoker*
STEAM PRODUCTION	AVERAGE	31,500 lbs. per hour	40,000 lbs. per hour
	MAXIMUM	36,000 lbs. per hour	50,000 lbs. per hour
ANNUAL COAL COST		$95,300	$76,940
MAINTENANCE PER YEAR		$1,700	$150

A. S. Barker, chief engineer
Kieckhefer Container Co.

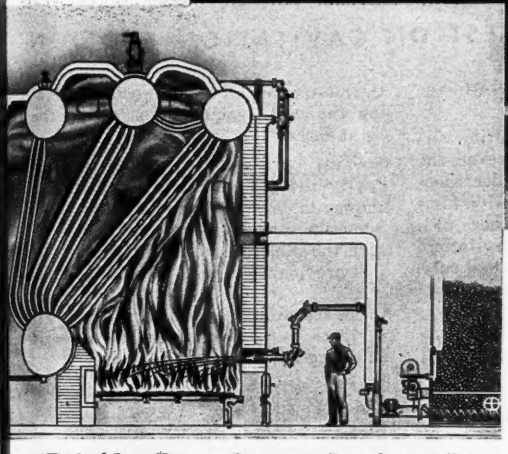
Iron Fireman saves $19,910 a year in fuel and maintenance, a cut of 20.5%, while increasing average steam production 27%.

Mr. A. S. Barker, Kieckhefer's Chief Engineer, lists other advantages in addition to lower steam costs. Says Mr. Barker: "The Iron Fireman stoker responds much more rapidly to the demand for steam than the former stoker. Also, we have noticed a considerable reduction in ash pit losses. On January 11, 1945, another Iron Fireman spreader type stoker was installed under our No. 5 boiler. This is operating very efficiently and satisfactorily. In the near future we expect to equip another of our boilers with the same type stoker. We have found that our outage time has been greatly reduced, which has increased our over-all boiler efficiency." Mr. Barker attributes Iron Fireman's low maintenance costs to the fact that there are no mechanical parts exposed to furnace temperatures.

Heavy Duty Pneumatic Spreader Stokers



Power plant of the Kieckhefer Container Co., Deiair, N. J., which equipped one boiler with an Iron Fireman stoker in 1941 *and is gradually adding others.*



Typical Iron Fireman Pneumatic Spreader installation in bent tube type boiler. This model feeds direct from main bunker, eliminating manual coal handling or mechanical coal conveying systems. Forced draft air supplied by separate fan unit, not shown.

THE IRON FIREMAN PNEUMATIC SPREADER STOKER

meters steam size coal from hopper or main coal bunker to transfer housing, where coal is picked up by pneumatic conveyor and delivered to furnace. The conveyor nozzle accurately spreads the larger particles of coal over the entire grate in a shallow, uniform fuel bed. The preheated fines burn in suspension, reducing the cinder carry-over and greatly improving the combustion efficiency and responsiveness, as compared with other stokers which do not preheat fuel.

There is an Iron Fireman for every Industrial Firing Need

Iron Fireman stokers have served American industry for more than 20 years, having been successfully applied to almost every conceivable type of firing job, in many thousands of installations. There is an Iron Fireman for every firing need.

Iron Fireman advantages include: 1. More efficient combustion, which cuts fuel consumption; 2. Ability to burn low grade coals efficiently; 3. Backing of a thoroughly competent and experienced engineering staff and service organization, which insures correct installation and effective maintenance; 4. Automatic controls which regulate fuel and air to the steam demands and maintain high efficiency and uniform steam pressure over the full load range.

FREE SURVEY. Iron Fireman's nation-wide sales, service and engineering organization will upon request make a survey of your boiler room, in conjunction with your own engineers if you so desire. This survey will give you valuable information on the efficiency of your plant, and will involve no cost or obligation on your part. For survey or technical literature write to Iron Fireman Manufacturing Company, 3850 West 106th Street, Cleveland 11, Ohio. Other plants in Portland, Oregon; Toronto, Canada

IRON FIREMAN

THE IRON FIREMAN

Learn the story behind this damage

Cavitation-erosion ruined these blades. Especially designed to improve pump efficiency, this impeller was ruined by cavitation in less than four weeks. But the design was not abandoned. The eroded impeller was replaced with one made of a nickel alloy — "S" Monel. At last check, it was still in service after 2½ years — over a 3000% improvement!

A 5 MINUTE QUESTION AND ANSWER DIGEST ON CAVITATION-EROSION

THE PROBLEM

Q. What is meant by cavitation-erosion?

A. Cavitation-erosion (or simply "Cavitation") is the type of erosion caused by collapse of tiny bubbles in a liquid, with consequent hammering of the liquid against the metallic surface.

Q. Where may cavitation be encountered?

A. The inertia of a rapidly-moving liquid makes it tend to continue in a given direction rather than to follow the contours of the metallic surface over which it is flowing. This may create voids. The rush to fill them causes the cavitation. In power plants, for example, it is a particularly destructive phenomenon.

Q. Are these voids a complete vacuum?

A. No, the space is filled with vapor from the liquid and with dissolved gases that may be present.

Q. What causes the damage?

A. When the voids collapse, there results a pounding by the fluid comparable to the destructive force of tiny bullets impinging against the metallic surface. With thousands of voids collapsing every minute, the cumulative result is powerful enough to cause deformation and fatigue, and to remove films which might inhibit corrosion.

Q. How are cavitation and corrosion related?

A. Corrosion intensifies cavitation; and cavitation accelerates corrosion. Thus, a self-sustaining chain of destruction exists.

Q. How does corrosion intensify cavitation?

A. The roughened surface of a corroded metal affords greater opportunity for the formation and the collapse of voids.

Q. How does cavitation accelerate corrosion?

A. With many metals the initial corrosion rate is very rapid. However, the speed of the attack usually decreases due to the formation of protective films of the corrosion products. If these protective films are removed by cavitation, corrosion proceeds at an abnormal rate. *That is why use of corrosion-resisting metals and alloys is so important!*

THE REMEDY

Q. What important factors govern control of cavitation?

A. Laboratory and field studies indicate that the most important factors are:—

1. Proper design.
2. Resistance to corrosion fatigue.
3. Resistance to corrosion and freedom from pitting.
4. Tenacity of protective films, and speed of new film formation.
5. Strength, hardness, and ability of a metal to withstand over-stressing and to distribute locally-applied stresses.
6. Susceptibility to strain hardening.
7. Uniformity of grain structure.

Q. Why is design so important?

A. Poor design (inadequate streamlining) has proved to be the leading single cause of cavitation. And, its effect is intensified by a high velocity liquid flow.

Q. Doesn't this all boil down to developing the best design and selecting the right metal?

A. Yes! Both are very important and really interdependent. Sometimes a change in design will reduce cavitation. Sometimes, as in the impeller in the picture, the same design in a different metal will provide the remedy. *Consider both!*

Q. Design can be guided by skill and experience, but how can one be guided in selecting the right metal?

A. *Past performance!* Laboratory tests and field use have for years indicated that a group of high-nickel alloys should be considered wherever cavitation-erosion is a possibility.

Q. What is this group?

A. The corrosion-resisting INCO Nickel Alloys — nickel, Monel, "K" Monel, "H" Monel and "S" Monel. Their resistance to cavitation has been amply demonstrated by their successful use to replace other metals in high-speed propellers, pump impellers, hydraulic valves, agitators and in similar parts.

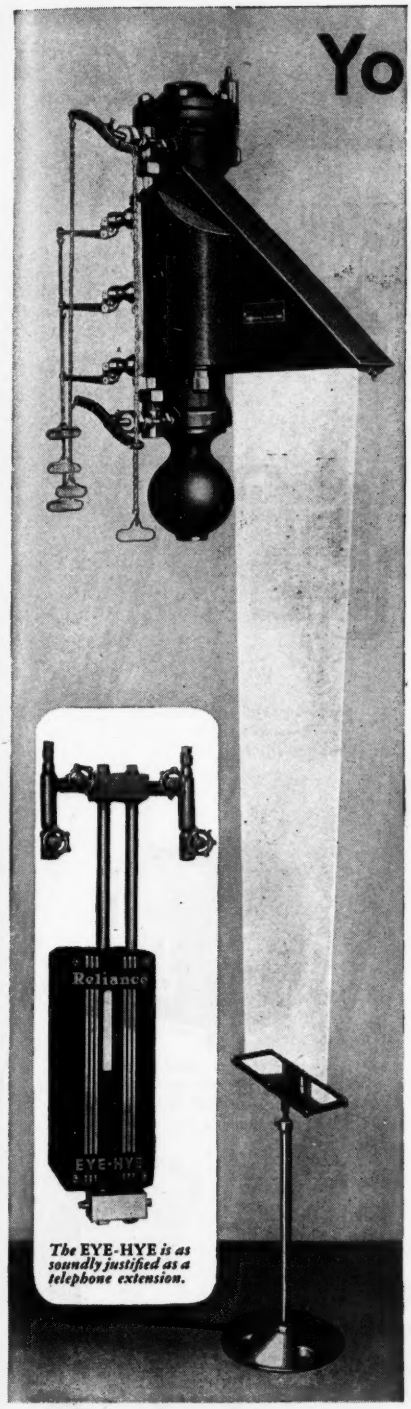
Q. Can INCO Nickel Alloys be used to build up parts that have already suffered cavitation-erosion?

A. Yes, and this ability is a big help on many repair jobs. For example, deposition of Monel or "K" Monel by arc-welding is an excellent way to build up eroded steel parts.

Q. How can more help be obtained on combating cavitation-erosion?

A. The International Nickel Company, Inc. has compiled a large amount of information on cavitation and will make all this accumulated experience available to anyone who needs it. Write: The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Reprints of this advertisement are available upon request from The International Nickel Company, Inc.



The EYE-HYE *is as soundly justified as a telephone extension.*

You are definitely *Dollar-Wise*

when you provide extra safety and efficiency through *duplicate* water level supervision . . .

The Reliance Safety Team double check way *means convenient frequent checks at boiler & control point*

The cost is extremely small—in view of advantages gained—to make your water level indicating installation *complete.* You aren't likely to "shoot the works and hang the cost" as the military forces have to do. So you're not extravagant when you have sensible duplication in your indicating equipment.

This Reliance *double check* gives assurance that boiler room men have ample warning of unsafe or inefficient water levels; through *sound* when the Alarm Water Column whistle blows—through *sight* as EYE-HYE shows an accurate reading at all times, conveniently duplicating at control station or other remote point the reading of the boiler drum gage.

RELIANCE WATER COLUMN EQUIPMENT

RELIANCE EYE-HYE REMOTE READING WATER LEVEL INDICATOR

Water Columns for all pressures, with and without alarms, and complete "trim equipment" have been the sole interest of Reliance since 1884. Your requirements can be filled with Reliance Gage Valves, Gage Inserts, and Gage Illumination.

EYE-HYE is a convenient auxiliary that brings your water level reading to instrument panel or wall, showing exact indication in a brilliant illuminated green column. Its action is completely hydrostatic . . . dependable and accurate.

Write for full information about the Reliance Safety Team.

BOILER SAFETY DEVICES since 1884

Reliance

THE RELIANCE GAUGE COLUMN CO. • 5902 CARNEGIE AVENUE • CLEVELAND 3, OHIO

TESTED IN WAR

FOUR STARS
ON OUR E PENNANT
TESTIFY TO SARCO
PERFORMANCE
IN THE WAR EFFORT

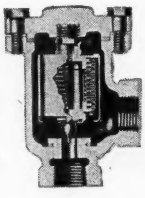
Three important facts will emerge from the war effort—thrice recognized by the Army and Navy E:

1. **Both the capacity and accuracy of Sarco production have been increased by new methods and equipment.**

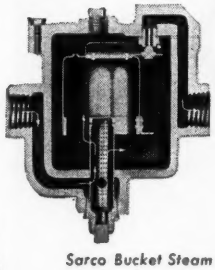
2. **In the interim of four years, new developments that were in the making have been pushed ahead. New Sarco traps and controls are now available.**

3. **The urge for mass production of war material with high accuracy and speed has brought about new applications of Sarco products. The result: modernization of your steam and hot water facilities can set your plant ahead by about ten years!**

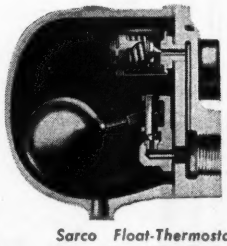
A few reminders of Sarco Service are illustrated on these pages. Let's look at a few of the developments that will improve your product, speed your production and lower your fuel and metered water costs. Ask for the Sarco Hook-Up Book.



The New Sarco No. 9 Thermostatic Steam Trap with high efficiency and capacities. Bulletin No. 250.



Sarco Bucket Steam Trap—for pressures up to 900 lbs. Bulletin No. 350



Sarco Float-Thermostatic Steam Trap. Three ranges—up to 2" and 200 pounds. Bulletin No. 450

Sarco 87—Low cost Trap-Control for tanks and outdoor service. Bulletins 250 and 550.

Represented in Principal Cities

SARCO

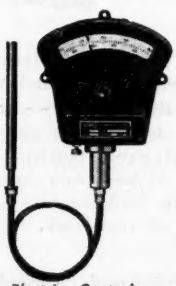
SARCO COMPANY, INC., 475 FIFTH AVE., NEW YORK 17, N.Y.

READY FOR PEACE

Sarco TR-21 Temperature Regulator for accurate, reliable control of hot water and process work. Bulletin No 600.

Sarco TR-40 — Low cost Cooling Control for compressors, stills, degreasers, etc. Bulletin No 700.

Sarco Water Blenders for showers, Diesels, brine and process work Bulletin No. 800.



Sarco Electric Control—High accuracy, low cost—for plating, food, chemical, heating or cooling. Bulletin No. 1025.

The well known Sarco No. 9 now has doubled capacity for the discharge of condensate or air! This means thermostatic efficiencies with the speed and power of a bucket trap.

The Sarco No. 87—a combination trap and control, is now available in many forms—for tanks—out-door heater lines, and many new applications. It costs little more than a trap—much less than most forms of control.

Sarco TR-21 and KR-14 temperature controls for liquids, air and gases have been improved—supplemented by a series of rigid stem controls.

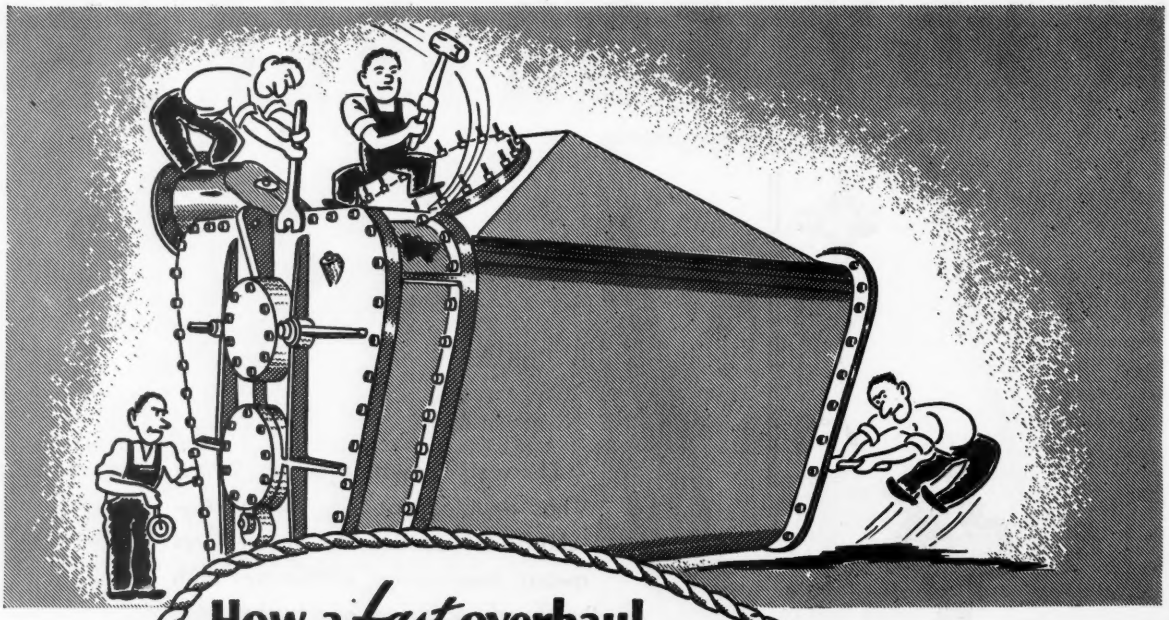
Sarco TR-40 Cooling Control is saving up to 50% of metered water on degreasers, stills, compressors, condensers and other cooling processes.

Sarco Blenders, now available in three types, are saving heat, hot water and tempers, on showers, Diesel engine jackets, brine coolers and process work.

Sarco Electric Controls have proven high accuracy on chrome plating, chemical stills, and food curing. Ask the nearest Sarco representative.

Saves Steam

• Sarco Canada, Ltd., 85 Richmond St., W., Toronto 1, Ont.



How a *fast* overhaul on a ship's disabled condenser *saved 25 days and $7,500*

RECENTLY, a fully loaded ship carrying vital war supplies blew up a condenser shell just before sailing time. The shell was corroded beyond repair. By phone, the port engineer asked us to hop a train and look the job over.

After an inspection of the unit, the port engineer asked how long the condenser repairs would take. Our man said, "About 96 hours, if we do it our way." (Other organizations had previously estimated 30 days for the job.) The port engineer suggested that our man add a few days to his estimate to be on the safe side, and phoned the general manager for permission to give us the job.

We immediately sent our own crew down, and within 5 days the ship was ready to sail. Our price for the job was $12,500. Two other concerns estimated 30 days for the project and quoted approximately $20,000.

About a month later the general manager accidentally ran across our man and asked: "How in the blazes did you replace that big condenser so fast, and without dismantling the ship's grating, skylights, ladders, etc."

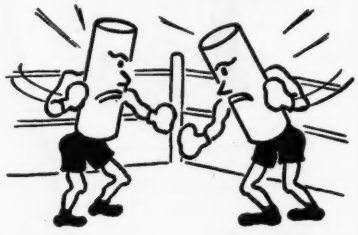
HERE'S HOW WE DID IT

Our man told him: "We chopped the old cast-iron water box into small pieces, made a temporary new one out of steel, built a new shell in sections and used the old tube sheets and tubes. Incidentally, our price included a new cast-iron water box which is already delivered, so you can replace the steel one we installed, at your convenience."

The general manager replied that, if it hadn't happened right in his own yard, he wouldn't believe such a condenser could be repaired in so short a time.

Hints on Keeping Your Condenser in Fighting Trim

Detect Weak Tubes by Shock Test — The 10-year-old Conseco Hydrodynamic Shock Test destroys tubes ready to fall anyway. Frequently, less than ten percent of the tubes in large condensers require replacement, but, unless discovered and removed, they will soon necessitate another shut-down and even major overhaul.

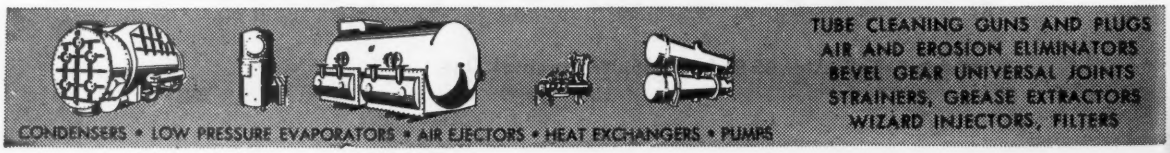


Why not have a Condenser overhaul to detect and minimize condenser troubles before they happen — while your system is down for a general checkup? Condenser Service has seventeen years of know-how experience in designing, building and servicing every type of condenser.

A highly skilled, specially equipped service organization, ready for immediate action anywhere on the continent, backed by engineering and manufacturing facilities producing over 3,000,000 sq. ft. of heat exchangers annually.

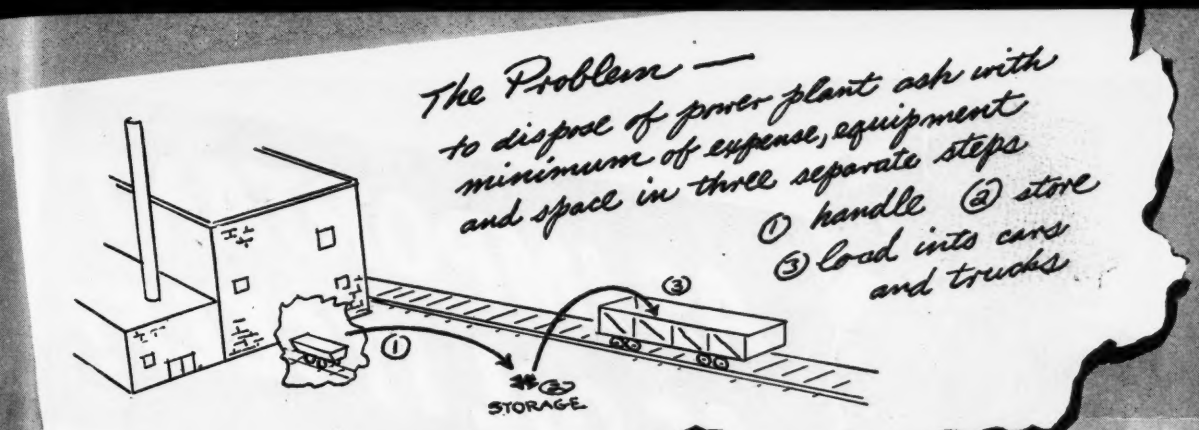
SERVICE

CONDENSER SERVICE & ENGINEERING CO., INC.



CONDENSERS • LOW PRESSURE EVAPORATORS • AIR EJECTORS • HEAT EXCHANGERS • PUMPS

TUBE CLEANING GUNS AND PLUGS
AIR AND EROSION ELIMINATORS
BEVEL GEAR UNIVERSAL JOINTS
STRAINERS, GREASE EXTRACTORS
WIZARD INJECTORS, FILTERS


The Problem —
to dispose of power plant ash with minimum of expense, equipment and space in three separate steps
① handle ② store
③ load into cars and trucks
①
②
③
STORAGE

The Solution— AN S-A SKIP HOIST

★ Drawing on their vast background of experience and their complete line of material handling units, S-A engineers met the needs of this power plant with the system shown.

Previously ash was collected in dump cars on a basement track beneath the boilers. S-A recommended extension of the track, loading an S-A Skip Hoist to carry ash to an overhead tile storage silo, from which it can be spouted to cars or trucks. The result is an installation that eliminates an objectionable outside storage pile, eliminates rehandling and holds ash handling cost down.

An S-A Skip Hoist like this one can be used for practically any bulk material—lump or fine, corrosive or abrasive. It can lift materials to heights with a minimum of supporting structure. It is simple in design, has a minimum of moving parts, and cuts maintenance to a minimum.

Whether your bulk material handling operations call for a skip hoist or any other equipment, call on Stephens-Adamson for a cost-reducing, time-saving installation.

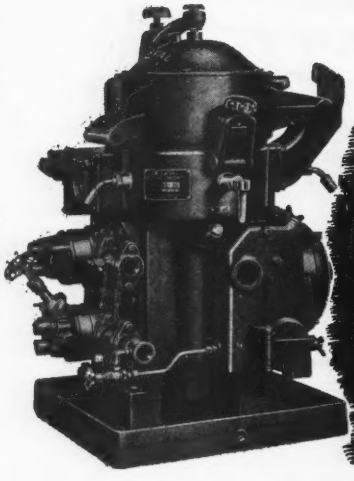
Photo shows S-A Skip Hoist for raising ash to storage silo. Operation is semi-automatic, with the hoist started, elevated, dumped and returned for a new load by push button control.

STEPHEN S-A ADAMSON MFG. CO.

515 RIDGEWAY AVENUE, AURORA, ILLINOIS — LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Designers and Manufacturers of All Types of

BULK MATERIAL HANDLING EQUIPMENT



AS IMPORTANT AS OIL ITSELF!

DE LAVAL OIL PURIFIERS make possible to a maximum degree the one thing as important in prime mover lubrication as an adequate supply of proper oil—the means of maintaining that oil in "like-new" condition.

•

BECAUSE - De Laval Oil Purifiers effect purification entirely by means of a constant centrifugal force. From the start of a run until the bowl is filled with dirt, the same centrifugal force acts on the oil. This "constant efficiency" feature assures a maximum removal of solid impurities or dirt . . . and the simultaneous continuous removal and discharge of moisture leaves the oil so clean and dry that it is the finest protection any bearing or moving part can be given.

The De Laval centrifugal helps maintain in any oil the properties given it at the refinery. . . . When oil is circulated on continuous by-pass, through De Lavals of proper capacity, it is purified from three to four times daily. Either a De Laval Oil Purifier by itself, or in the case of turbines, a complete De Laval-Funk Process, will continuously keep the oil so pure that failures chargeable to impure lubricating oil are entirely ruled out.

● Write for additional information.

ADVANTAGES OF DE LAVAL LUBRICATING OIL PURIFIERS

Constant high purifying efficiency—without renewal of functional parts

•

Economical to operate

•

Remove both enemies of good lubricating oil performance: water and dirt

•

Provide maximum protection to power units

•

Give long, trouble-free service

•

Lower maintenance costs

•

Maintain oil in condition most nearly identical with that of new oil

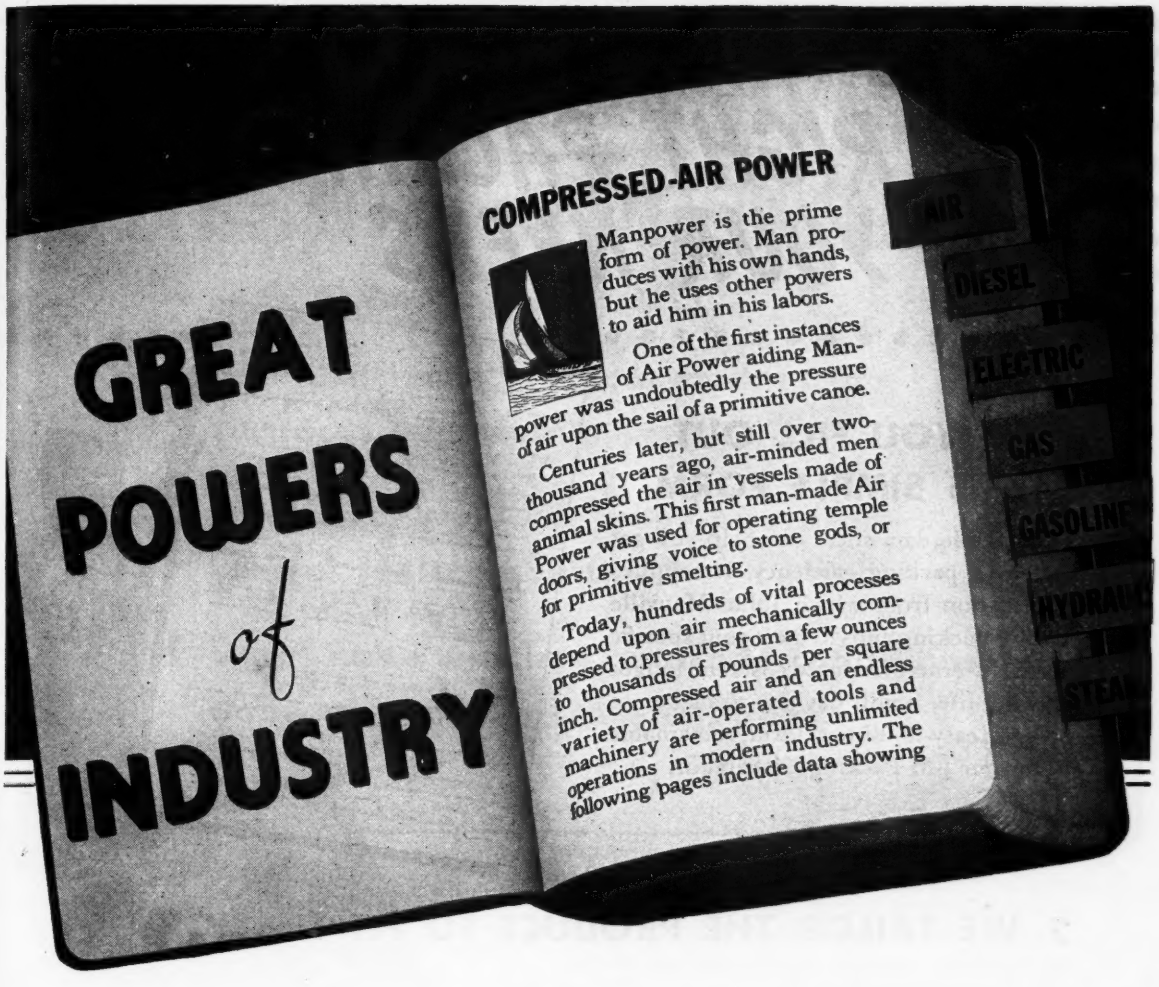
•

Self-draining purifier bowl makes for easy cleaning

DE LAVAL

LUBRICATING OIL PURIFIERS

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 19
THE DE LAVAL COMPANY, Limited
MONTREAL PETERBOROUGH WINNIPEG VANCOUVER


GREAT
POWERS
of
INDUSTRY
COMPRESSED-AIR POWER
Manpower is the prime form of power. Man produces with his own hands, but he uses other powers to aid him in his labors.
One of the first instances of Air Power aiding Manpower was undoubtedly the pressure of air upon the sail of a primitive canoe.
Centuries later, but still over two-thousand years ago, air-minded men compressed the air in vessels made of animal skins. This first man-made Air Power was used for operating temple doors, giving voice to stone gods, or for primitive smelting.
Today, hundreds of vital processes depend upon air mechanically compressed to pressures from a few ounces to thousands of pounds per square inch. Compressed air and an endless variety of air-operated tools and machinery are performing unlimited operations in modern industry. The following pages include data showing
AIR
DIESEL
ELECTRIC
GAS
GASOLINE
HYDRAU
STEA

This book is not for sale . . . as far as we know, it does not exist.

If it did, such a book would point out the types of work that can be accomplished by *several* forms of motive power used by industry . . . the problems that can be solved *better by one* than by any other . . . the things that can be done by *only one* of them . . . and the still other jobs that require *combinations* of several powers.

In the absence of such a book, we must all depend upon experienced engineers and manufacturers to advise us of the very latest practices in their particular fields.

So if you are not thoroughly familiar with *Compressed-Air Power* . . . what it is doing for others, and what it can do for you . . . get in touch with an Ingersoll-Rand Engineer. He knows Air Power and its applications.

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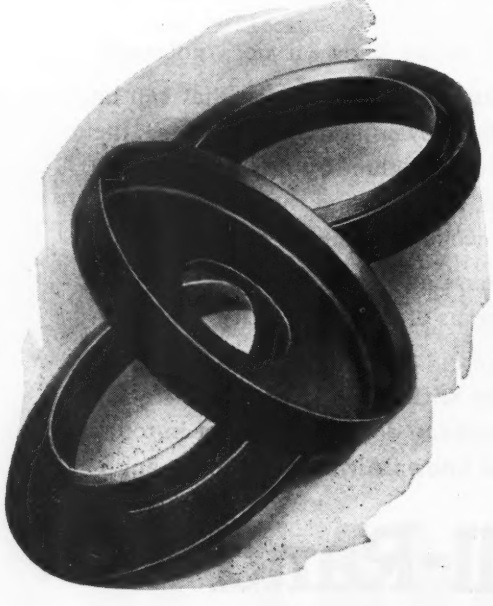
HOW TO GET

THE RIGHT PACKING CUP FOR YOUR NEEDS

1. YOU FILL OUT THIS SIMPLE FORM

This simple data sheet can help you get increased packing efficiency. It supplies information from which Johns-Manville moulds packing cups to meet your specific needs. In terms of reduced costs and longer packing life, it will pay you to make use of this easy-to-fill-out form, obtainable from your J-M Packing Distributor.

2. WE TAILOR THE PRODUCT TO FIT THE JOB



From this information, J-M Moulded Packing Cups are "custom-tailored," moulded to your requirements in shape and size, as well as composition. This may vary, depending on whether they are to seal against air, water, steam, oil, etc., or to operate against high or low pressures and temperatures. The result is a packing cup that wears longer and provides a positive seal with minimum friction on all types of hydraulic and pneumatic equipment.

With these tailor-made J-M Packing Cups, you can be sure of getting the right packing . . . *right* in composition, size and shape for *your* needs. For further details write Johns-Manville, 22 East 40th Street, New York 16, N. Y.

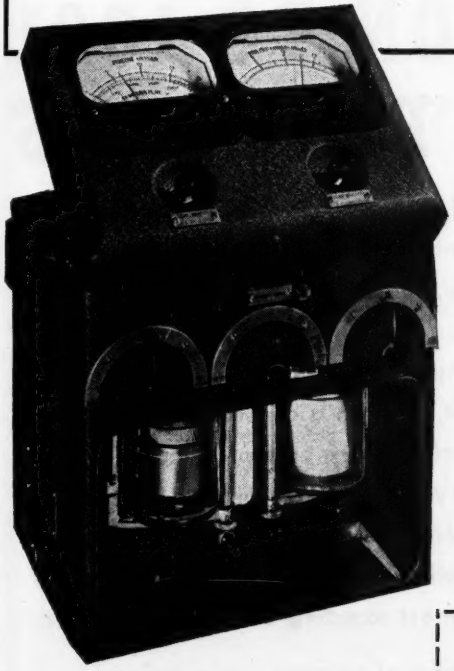
Johns-Manville

PACKINGS & GASKETS

THERE'S A DISTRIBUTOR NEAR YOU

CAN YOU ANSWER THESE 3 QUESTIONS?

1. **How efficiently do your boilers or furnaces burn fuel?**
2. **How accurately can your operators control fuel combustion?**
3. **What have wartime overload conditions done to your fuel consumption?**



If you can't answer these questions, you can find your answers—in just a few minutes—with the Cities Service Industrial Heat Prover.

This unique instrument, exclusive with Cities Service, registers quickly and continuously the per cent of oxygen and combustibles present in the escaping gases or in the furnace atmosphere. Shows you how to burn fuel efficiently and economically.

Invaluable for checking furnace atmospheres in the heat treatment of metals.

This instrument represents just another contribution by Cities Service to wartime conservation of critical material.

Take advantage of the free demonstration offer on your own equipment...at no obligation.*

(Available only in Cities Service Marketing Territories East of the Rockies).

CITIES SERVICE OILS — ONCE-ALWAYS

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Mail this coupon today for further information

Cities Service Oil Co.
Room 403, 70 Pine Street, New York 5, New York

Gentlemen: Please send me further information on your free demonstration offer of the Cities Service Industrial Heat Prover—at no obligation to me.

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"Flexitallic"...

REG. U. S. PAT. OFFICE

Flexitallic C-G (Compression Gauge) gaskets illustrated are available for all temperatures and pressures including the 2500 ASA flange standards.

THE SOLUTION TO 1001 GASKET PROBLEMS

When Flexitallic originated resilient spiral-wound gasket construction over a third of a century ago, working pressures ranged from 150 to 300 lbs. Today, pressures of 1500 lbs. (and even 2500 lbs.) are not uncommon. Extremely high temperatures and difficult conditions involving liquids, gases, or chemicals are frequently encountered—yet, through a constant process of development, Flexitallic has solved each new problem as it arose—and has anticipated many of them. No other company has concentrated research and engineering so fully on one type of gasket construction. None other can match Flexitallic in offering a service geared to the most exacting of today's demands.

High or Low Temperatures

•

High or Low Pressures

•

Liquids, Gases, or Chemicals

•

Specifically designed for actual working conditions

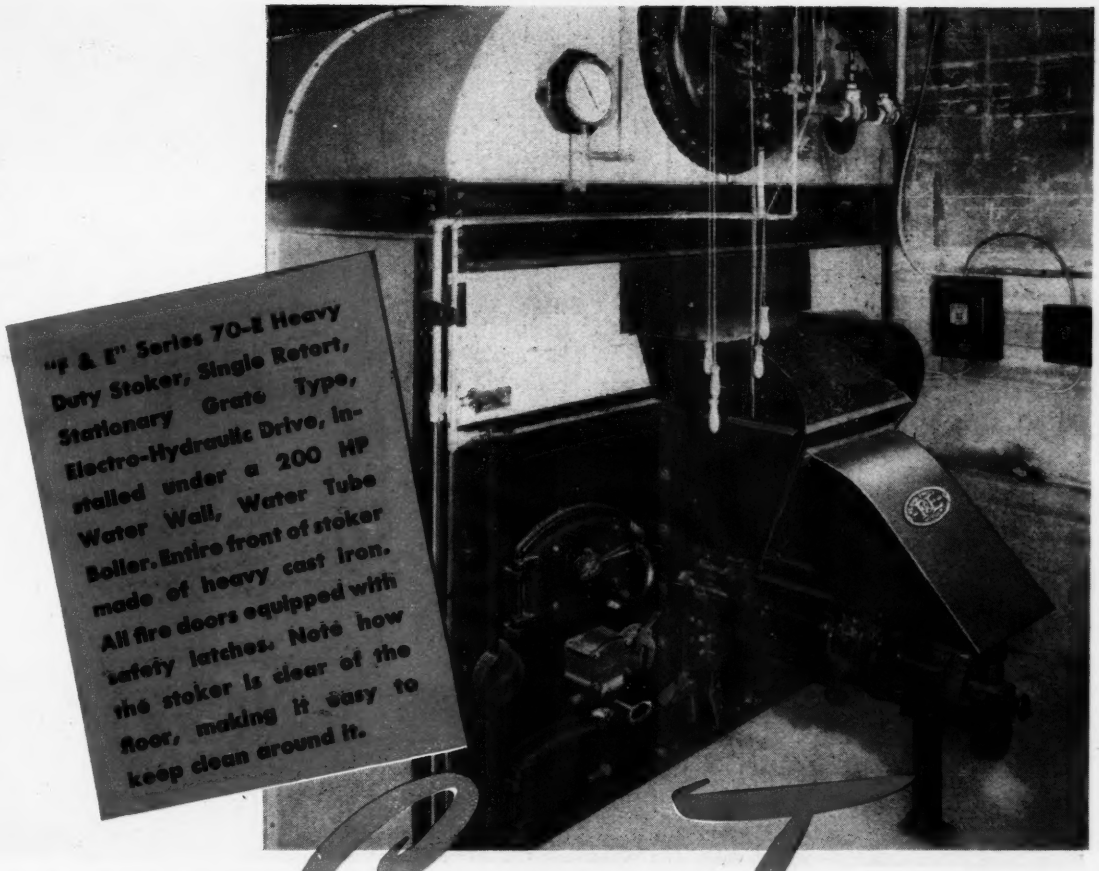
•

All types and shapes for all pipe flanges and pressure vessels

Given the simple necessities of adequate seating surface and bolting, there is no gasket problem Flexitallic can't beat!

FLEXITALLIC GASKET COMPANY • 8th & BAILEY STREETS • CAMDEN, NEW JERSEY

ORIGINATORS OF THE SPIRAL-WOUND GASKET — SPECIALISTS IN SPIRAL-WOUND GASKETS EXCLUSIVELY FOR OVER A THIRD OF A CENTURY


"F & E" Series 70-E Heavy Duty Stoker, Single Retort, Stationary Grate Type, Electro-Hydraulic Drive, installed under a 200 HP Water Wall, Water Tube Boiler. Entire front of stoker made of heavy cast iron. All fire doors equipped with safety latches. Note how the stoker is clear of the floor, making it easy to keep clean around it.

"F & E" SERIES 70-E UNDERFEED STOKERS

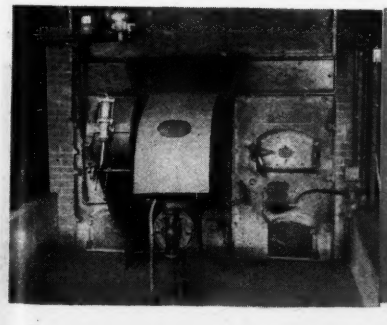
Sure-Fire

Powerful and positive in action, the Series 70-E Stoker with the "F & E" patented Electro-Hydraulic Drive will dependably feed and burn coal sufficient to generate up to 40,000 lbs. of steam per hour.

Recognized as the most simple and flexible . . . the most rugged and dependable stoker drive ever developed, the "F & E" Electro-Hydraulic Drive is trouble free under every fuel feeding condition. All working parts are fully enclosed and operate in oil. No pipes, valves or fittings to leak or give trouble.

No gears, ratchets, shear pins or complicated mechanism to break down. "F & E" features include the interval timer governor that regulates Full Stroke, Full Speed ram action so essential to dependable steam generation. Result—*uninterrupted sure-fire* performance at all times!

Investigate "F & E" Stokers—check into the "F & E" combination of six engineered features that assure you dependable, *sure-fire* production of steam for your requirements.



Front view of "F & E" Series 70-E Electro-Hydraulic Drive Stoker, Unit Type, for capacities up to 18,000 lbs. of steam per hour. A constant speed electric motor operates the Electro-Hydraulic Drive, with power transmitted through a specially designed, high-duty, hydraulic gear pump, which in turn, supplies oil under pressure for operating the hydraulic cylinder and piston.

FLYNN & EMRICH CO.

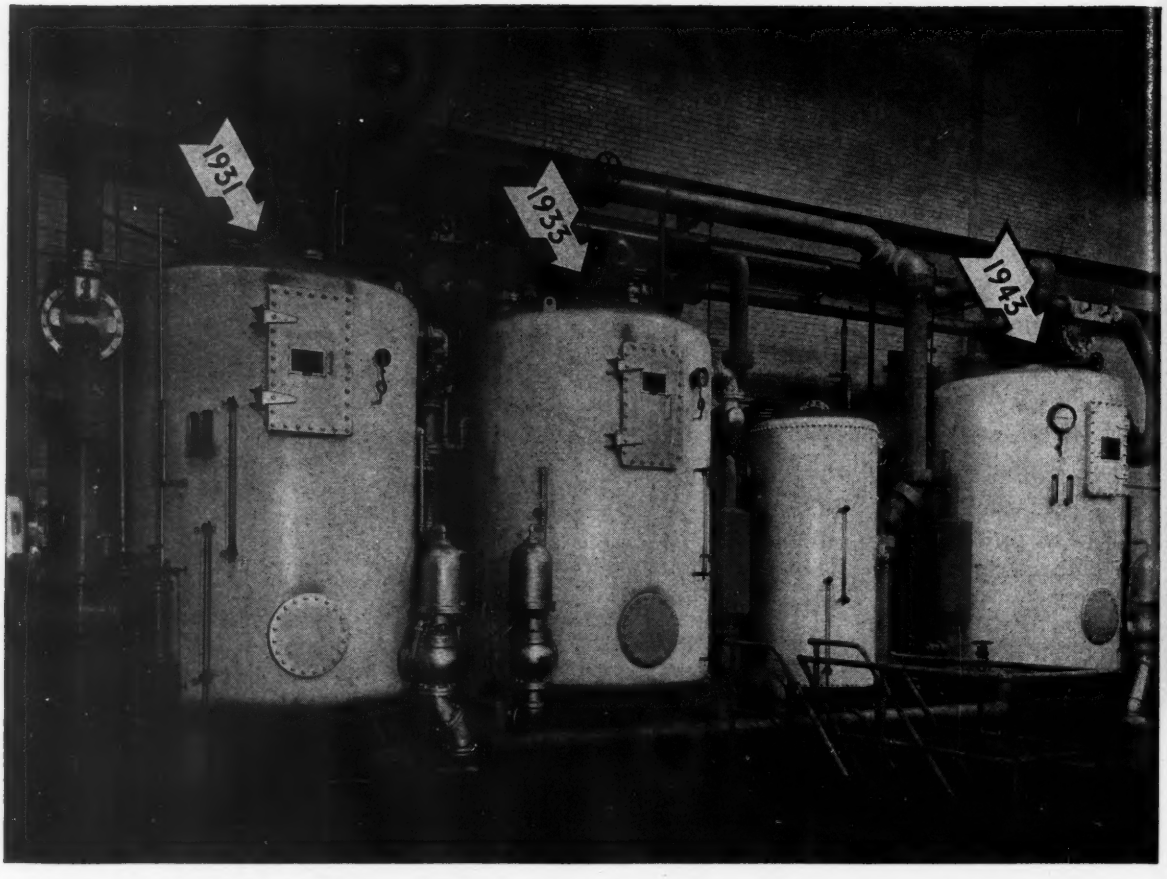
Established 1842

HOLLIDAY & SARATOGA STREETS, BALTIMORE 2, MARYLAND

Representatives in Principal Cities

UNDERFEED STOKERS

HYDRAULIC DRIVE AND STEAM DRIVE FOR BOILERS PRODUCING 10,000 TO 40,000 LBS. OF STEAM PER HOUR



"AND NOW THERE ARE THREE—"

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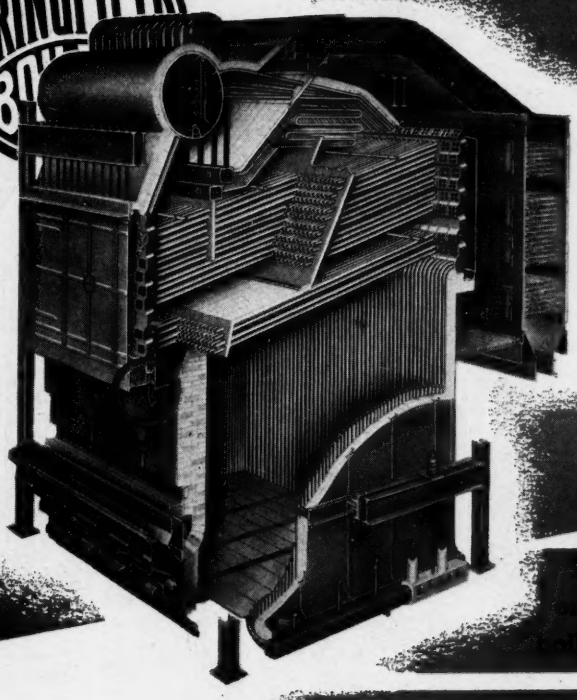

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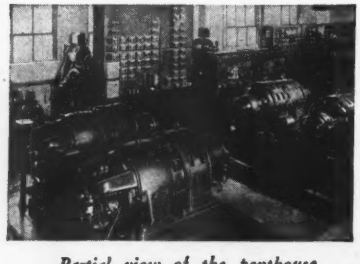

Partial view of the penthouse machine room after Otis Modernization.

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But, after being changed over to Otis Peak Period Signal Control, only four elevators were required to handle the traffic during busy periods. During slack periods, *only three cars were required.*

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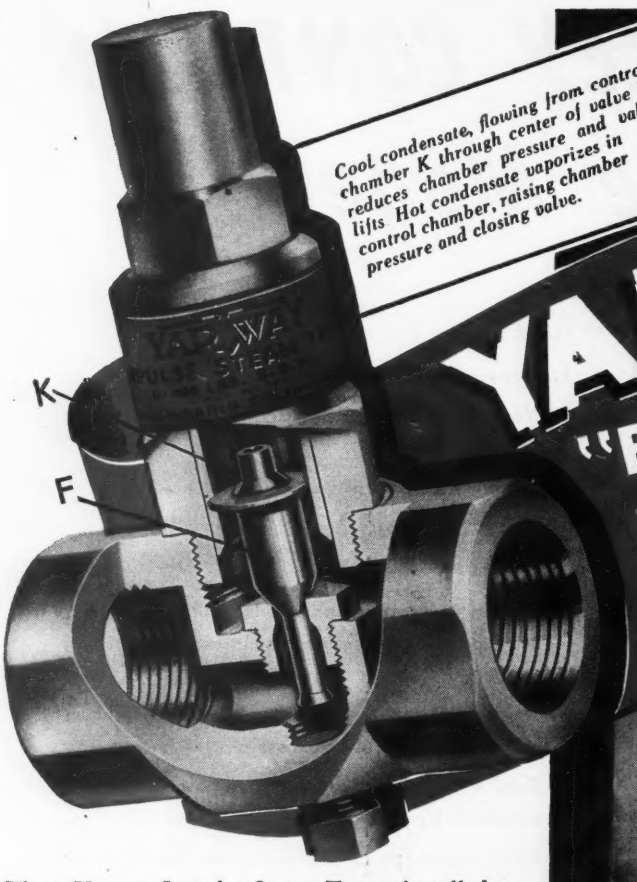
Cool condensate, flowing from control chamber K through center of valve F, reduces chamber pressure and valve lifts Hot condensate vaporizes in control chamber, raising chamber pressure and closing valve.
K
F

YARWAYS "BRING HOME THE BACON" AT GOLD MEDAL PACKING

These Yarway Impulse Steam Traps, installed on an Atmos Smokehouse at Gold Medal Packing Corp., Utica, N. Y., are but two of many Yarways doing an excellent trapping job for them on cookers, smokehouses, and hot water heaters.

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Straight-through piping and small size simplify installation and maintenance. Already, over 400,000 Yarways have been purchased. Frequently it costs no more for new Yarway Impulse Steam Traps than to repair old type traps. See your local Mill Supply Dealer or write for Bulletin T-1739

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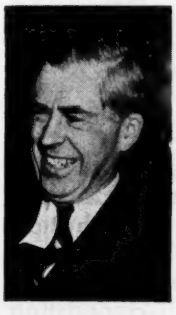
YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Lots of Enterprise, Free and Independent

By HENRY A. WALLACE

Secretary of Commerce of the United States



I HAVE BEEN called a lot of things: a planner, a dreamer—in fact, it's amazing what I've been called. Not many people remember to call me a business man. Yet I have been in business for many years — in fact, right up to the time I became Secretary of Agriculture.

Today, as Secretary of Commerce, I face the job of utilizing my own experience, along with the expert knowledge of others, including the business fraternity of the country, to help bring America to new levels of prosperity. As everybody knows by now, I believe in full employment. The aim of full employment is total prosperity in peace as well as in war, not only for the industrial worker and the farmer, but for the business man as well. The general aim is to benefit all segments of the population. It boils down to the necessity for increased production and efficient distribution. If everyone who works produces more and his product flows through the distributive channels, there will be an increase in the standard of living.

Increased production delivers a three-way benefit — lower selling prices, larger earnings for manufacturers and distributors, and higher earnings for workers and farmers. As long as the output per individual is low, the opportunity to improve earnings and the standard of living is meager. When there are few opportunities open to the mass of the people, business as well as everyone else suffers.

How can the Department of Commerce help to realize this general aim? One way is to offer practical assistance to the smaller, independent business man.

I am a little leary about all the prevalent conversation about the "small business man." His problems are too many times regarded like the weather: "Everyone talks about it but nobody does anything about it." The Department of Commerce can be a doer of specific things rather than another place where the "small business man" gets a good talking over and little else.

Copyright, 1945, The Institute of Business Economics.

The national future depends in large part on an ever expanding and more prosperous number of independent business men. Today that group suffers many handicaps. The smaller independent business man isn't organized into a national association of representatively large membership. On government problems, of which there are so many in these days, he has no one who can represent him in Washington. He cannot afford to make any trips to Washington nor can he take the time from his business. He cannot hire expensive lawyers to speak for him. He can't call up his Washington branch office or his lobbyist and ask him to see So-and-So and get this-or-that done.

He should have one central place in Washington where he can write or go with his problems. Right now there is no one door on which the small and independent business man can knock, where he will be welcomed and given concrete help. The Department of Commerce is the logical place for the business man to come. In itself it has much of the desired information.

In the valuable experience of the National Bureau of Standards, the Department has unparalleled sources of that technical "know-how" which has proved to be such a national asset in time of war. In this day of electric power, electronics, synthetics and plastics, the independent business man must be able to get involved know-how information if he is to compete. He should also have detailed "dope" about cheap and efficient processes and he should know how to get access to patents which he wants to use.

The distributor, who wants to participate in the prosperity coming out of full employment, also can get what he needs. The Census Bureau is the greatest fact-finding and statistical agency in the United States. If the independent business man who wants selling information avails himself of the fund of information gathered by the Census Bureau, and adapted by us to his needs, he will have at his fingertips market research data comparable to that of the biggest of our corporations.

The Bureau of Foreign and Domestic Commerce is another case in point. It has made studies on various aspects of business problems over a period of many years. The business man, wanting to know where he can go to get materials or what markets are in need of products such as he has to sell, can get light on these problems from the Bureau of Foreign and Domestic Commerce.

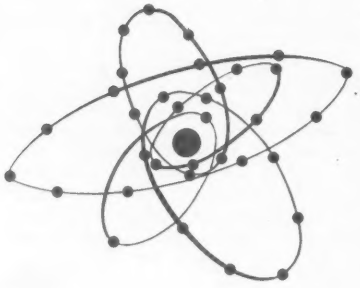
Remember I am talking about the realities of making a product, finding out how to sell it and to whom—with all the problems that involves, even including training of personnel and the correct way to figure costs and mark-ups. The area is big and so is the geography, covering not only business done in the United States but with the rest of the world.

Foreign trade must be greatly increased to maintain full employment and prosperity inside the United States. We must buy from our neighbors, if we are to sell to them. The independent business man rarely has the finances or the staff with which to explore the lands of our neighbors. If he is not to forfeit the new opportunity to the big fellows, already well entrenched, he must have quick, accurate and usable information. I propose that the Department of Commerce be the avenue by which the business man finds the way to the markets in other countries.

Many business men have had justifiable worries connected with the disposition of the great surplus of goods which is accruing as a result of war. Recently the Department of Commerce has been authorized by President Truman to undertake the sale of a large part of this surplus. It should be understood that as far as the Department is concerned, our effort will be to dispose of this so that it will get to the public through regular trade channels wherever that is possible. We are determined that speculators will not gobble up all the supplies and we are going to be equally careful that big companies, through subsidiaries, will not get the material at the expense of the smaller man.

The best markets in the United States are those areas where the standard of living is highest. Business men, along with workers, do better in the busy manufacturing areas of New England than they do on Tobacco Road. Our best foreign markets are with England and Canada because they, too, have been industrialized. The job is to get the whole population onto that desirable level. Most of the business in the country is done today with about one third of the population. The market ought to be and can be 100 per cent of the nation.

ATOMIC ENERGY IS HERE



The atomic bomb development and its implications for mankind . . . A brief account of atomic research and the events which led to the launching of the "Manhattan Project" . . . Factors involved in the plan . . . Difficulties of translating the results of preliminary experimental achievements into large-scale production plants . . . Cooperation of scientists, companies, governments and universities

By Andrew W. Kramer **Managing Editor, Power Plant Engineering**

THE EXPLOSION of the first atomic bomb at 5:30 a. m. (MWT) on July 16 in the desert lands 120 miles southeast of Albuquerque, New Mexico, was the beginning of a new era in this world—the era of Atomic Energy. Terrific as the actual explosion was, it was small, perhaps, in comparison to the mental explosion it created in people's minds throughout the civilized world. The news of it traveled all over the world in a matter of seconds, and in countless thousands of newspapers and over other countless radio stations, the terrifying implications of the discovery were made manifest. Simultaneously, with the announcement of that test explosion came the news of the dropping of such a bomb on Hiroshima in Japan at 6:24 p. m. (EWT) on August 5. The awfulness of the destruction caused by the bomb on Hiroshima and the one three days later on Nagasaki is only, now, becoming known. These two bombs are reported to have caused 480,000 casualties. According to Japanese broadcasts at the time of this writing, the bomb which fell on Hiroshima killed or injured 160,000 persons and left 200,000 homeless. The bomb which hit Nagasaki on Aug. 9 left 120,000 casualties.

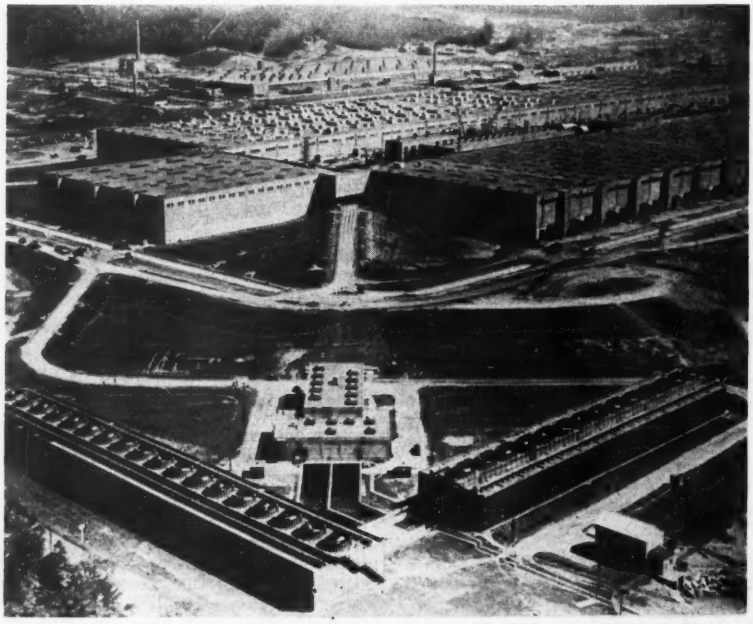


Fig. 1. The Clinton Engineer Works near Oak Ridge, Tennessee. This is an air view of the first of the three giant production plants involved in the production of the atomic bomb. (Acme photo)

What this release of atomic energy means in terms of a weapon of destruction needs little discussion, indeed, there are no words left to describe its implications in this respect. The prospect of the development of much larger bombs of this type spells little short of the complete annihilation of the human race. Whether this force can be kept within bounds, whether it can be made into a threat to insure the end of all wars is something that the politicians and the statesmen will have to decide but the prospects in this direction are discouraging.

There is another aspect to this development and this, perhaps, is more important than the production of the bomb itself; that is the possibility of using atomic energy for power. For many years, ever since the vast forces which hold the atom together were

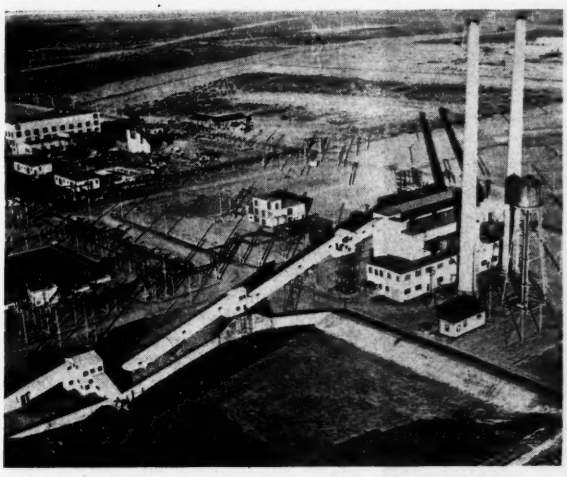


Fig. 2. A view of the Hanford Engineer Works near Pasco, Washington. (Acme photo)

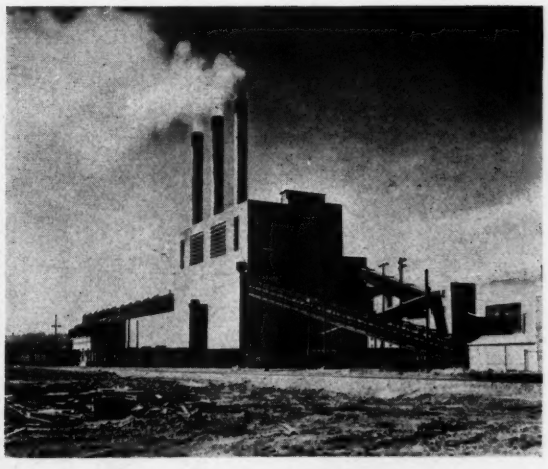


Fig. 3. The steam plant in one of the process areas at the Oak Ridge site of the Clinton Engineer Works. (Acme photo)

first made evident, scientists have dreamed of developing methods of using this energy for the benefit of mankind. It has been thought for years that if by some means science could succeed in unlocking these vast forces, a pound of ordinary matter, brick, steel, carbon, anything in fact, would release more energy than is contained in the chemical energy of thousands of tons of coal or oil. This has been the aim of a great deal of the atomic research that has gone on in the laboratories throughout the world during the last quarter of a century.

There has been much speculation about this, some of it optimistic, much of it pessimistic. Until only a few years ago, there was good reason for pessimism, even among scientists because there had been little evidence of an actual release of energy in any of the atomic experiments. During the past ten years, however, the picture changed. With the fission of uranium 235 (as explained in the following article) the amount of energy released was enormously greater than the energy required to produce the fission and this immediately gave scientists a renewed incentive for concentrating study of the subject. In the course of bombarding uranium with neutrons, Dr. Hahn in Germany had found barium among the products of the nuclear disruption. The fact that barium has about half the atomic weight of uranium led Dr. Meitner, an associate of Dr. Hahn, who subsequently moved out of Germany as a non-Aryan to consider the possibility that the slow-moving neutrons used to effect the bombardment, had actually split the uranium atom in two nearly equal halves. If this were true, she calculated that the split released energy of the order of 200 million electron volts, some 5 million times the energy evolved in burning an atom of coal.

Upon her arrival in Stockholm in January, 1939, Dr. Meitner communicated the essence of her findings to Dr. Otto Frisch, a nephew of hers in Copenhagen who in turn reported the matter to Prof. Niels Bohr who was leaving for America to work at Princeton with Dr. Einstein and at Columbia University with Dr. Fermi, a refugee from Italian Fascism in Rome. They confirmed Dr. Meitner's conclusions experimentally and called a conference of scientists at Columbia to make plans for extending the researches. In the meantime, Dr. Frisch in Copenhagen also verified the experiment.

This was the beginning. In England, other scientists took up the work and, undoubtedly, Dr. Hahn in Germany continued his researches for it was he who first found barium in the products of nuclear bombardment. Such progress was made that by the summer of 1941, it appeared that there was a reasonable chance that an atomic bomb could be produced before the end of the war. By the summer of 1942 the expanded research programs both in America and in England confirmed with surer and broader foundations the promising forecasts which had been made a year earlier, and the time had come when a decision had to be made whether or not to proceed with the construction of large-scale production plants. Meanwhile it had become apparent from the preliminary experiments that these plants would have to be something like the vast scale production units described in the releases made public last month.

Great Britain, at that period, was fully extended in war production and could not afford such grave interference with the current munitions programs on which war operations depended. Moreover, Great Britain was within easy range of German bombers and the risk of aircraft attack could not be ignored. The decision was therefore taken to build full-scale production plants in America.

Here, the erection of the immense plants was placed under the responsibility of Mr. Stimson, the Secretary of War, and the American Army Administration. The major practical effort and virtually the whole of its prodigious cost fell upon the United States authorities who were assisted by a number of British and Canadian scientists. Canada provided a most valuable contribution because of the rich deposits of pitchblend which existed in Canada and from which uranium is derived.

In America, the project which had begun in New York City was carried out under the code name "Manhattan Project." By December, 1942, it had outgrown the laboratory stage and operations were centered at three isolated plants. The first of these was on a 59,000 acre tract near Clinton, Tenn., 18 miles west of Knoxville. The town built for the workers is known as Oak Ridge and this has a population of some 78,000. The second plant was the Hanford Engineer Works, located on a 430,000 acre tract, 15 miles northwest of Pasco, Washington. The town built there is called Richland and this has a population of around 18,000. Laboratories and test grounds were located at Los Alamos, New Mexico, near Santa Fe.

In the original experimental work, it was found possible to produce fission only in uranium 235. Since this isotope of uranium exists in natural uranium only in the proportion of 0.7 per cent, the possibility of separating enough of this isotope to work with was rather poor. In the meantime, it had been found that plutonium, the transuranic element formed by bombarding uranium 238 with thermal neutrons, also underwent fission and so attempts were made to produce plutonium by a controlled, self-sustaining, chain reaction process.

By the fall of 1942 the first self-sustaining chain-reaction pile had been developed at the University of Chicago and on Dec. 2 it started

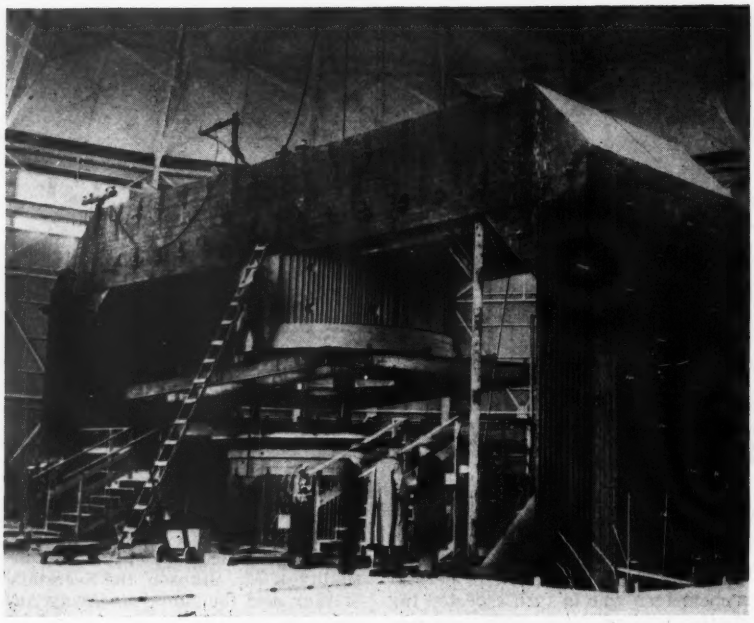


Fig. 4. This view is a picture taken during the construction of the huge, 4900-ton atom-smashing cyclotron at the University of California which played a prominent part in the researches which led to the development of the atomic bomb. This photograph was made as the job of winding the huge magnet was begun. (Acme photo)

operation. This was based on the lattice principle with graphite as the neutron-velocity moderator (slow neutrons are necessary in the process) and with lumps or rods of uranium metal or uranium oxide as the reacting units. It was calculated that to produce a kilogram of plutonium a day, such a chain-reacting pile would evolve energy at the rate of from 500,000 to 1,500,000 kw and this imposed a difficult cooling problem, one that required vast amounts of equipment.

All this huge equipment and these vast operations, aimed at producing plutonium on a mass basis, was founded purely on laboratory experiments performed with scarcely half a milligram of plutonium available. In peacetime no engineer or scientist in his right mind would consider making such magnification in a single stage, and even in wartime only the possibility of achieving tremendously important results could justify such a move. The ends, however, seemed to justify the effort and so it was made. There was also the knowledge that the Germans were working on the process. There are rumors that one crude atomic bomb was dropped in France with disastrous results to the Germans themselves but this has not been checked. Only history will tell how close the race was but it is probable that the enemy was on the right track and that we won the race by only a narrow margin of time.

How successful we were is attested by the results achieved at Hiroshima and Nagasaki. The whole project was one of wholehearted cooperation of individuals, companies and governments. Never was so vast and complex an undertaking carried through with less friction. Aside from the odd hundred thousand workers at the plants, thousands of scientists in Universities throughout the entire nation pooled their efforts and knowledge. Chief among the Universities involved in the Manhattan Project, were, Columbia, M. I. T., Chicago, Harvard, Princeton, Cornell, Minnesota, Pennsylvania, Illinois, California, Northwestern, and California Institute of Technology.

Among the companies engaged were M. W. Kellogg Co., Union Carbide & Carbon, Stone & Webster Engineering Corp., H. K. Ferguson Co., Tennessee Eastman Co., E. I. duPont de Nemours & Co., etc. In fact the list of companies that participated in the work included practically all the leading companies in American business. General Electric, Westinghouse, Allis-Chalmers, Harshaw Chemical, International Nickel, Chrysler, Davison Chemical and many others. Some companies constructed entire new plants just to supply the Manhattan Project. As was told in the newspaper accounts, the project cost around two billion dollars.

While the general pattern of the atomic bomb is known from the work that had been done before 1942, its actual construction is still, of course, a military secret. Just what mechanism is employed to set off the chain reaction is not disclosed in the Army report but several methods suggest themselves. It is known, for example, that the chain reaction in U235 can be started by velocity-moderated neutrons issuing from beryllium as a result of exposure to the alpha, beta and gamma rays of radium. Suppose, then, that a speck of radium is dropped on a small beryllium target in contact with the uranium; it is evident that the beryllium would instantly become a source of neutrons and these, after passage through a

Fig. 5. Dr. Alfred O. C. Nier, 27 year old physicist at the University of Minnesota who first succeeded in isolating uranium 235. Dr. Nier is shown holding the tube of the mass spectrometer with which he effected the separation of the isotope U235 from natural uranium. This shows the spectrometer tube with a small furnace fitted at one end. The positively charged uranium ions are fed out of the furnace into the tube. The curve of the tube is adjusted for the mass of the particular isotope being separated. (Acme photo)

velocity-moderating compound, would set off the desired reaction in the uranium. Or, a lead shield could suddenly be removed from the uranium compound to initiate the same action. The actual mechanism is comparatively unimportant. What is important is that it has been accomplished.

Now, as to the possibility of using this force in the production of power for useful purposes. Obviously, no one, probably not even those most closely associated with the bomb development are in a position to predict when, or if ever, this force can be applied commercially or economically for peacetime purposes. Uranium, it must be remembered, is a comparatively rare element and the cost of separating the uranium 235 or of synthesizing the plutonium may be such that the commercial use of the material may remain forever out of range. If history is any criterion, however, it would seem unreasonable to predict that despite the high costs at present, this thing is to remain forever out of our grasp. Comparison has been made with Dynamite and TNT; it is pointed out that the destructive forces of these explosives have long been used but that they have still not been used for producing electric power. This argument is not necessarily valid, however, because while it is true that the explosive force of TNT is enormous, yet when we compare the total available energy in a pound of coal and a pound of TNT, we find that the pound of coal has a great deal more energy than the pound of TNT. It is merely because the energy in TNT is released in so short a time that it is so effective an explosive. A pound of uranium, on the other hand, when considered from the standpoint of atomic energy has many millions of times the amount of energy that can be released in the chemical combustion of a pound of coal or any other fuel, and for that reason it may be quite possible to supplant the chemical energy of fuel with the atomic energy of uranium or perhaps other elements as well. The fact that fission has been produced in uranium does not imply that the same result cannot be achieved with some of our more common elements. R. A. Millikan is reported to have predicted that the atomic bomb development will not have any influence whatever, either now or in the future, upon the power industry. In view of what has already been accomplished, it seems that this is a rather arbitrary assertion, one not justified by the steady trend of progress in atomic research.

Already, it has been suggested that the controlled fission of uranium could be used to turn water into steam. This possibility seems quite within our grasp and if the supply of uranium 235 or plutonium can be made reasonably more abundant, even though the cost per pound is relatively high, the advantages of using such a form of fuel would be great.

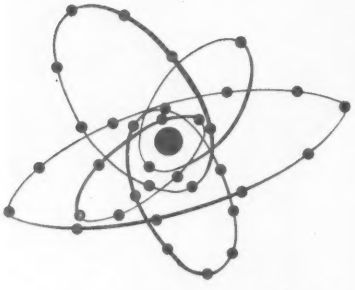
Fig. 6. A view at a cyclotron control board showing, left to right, Dr. John R. Dunning, Dr. R. T. Booth and Dr. A. V. Grosse, all of whom did much of the preliminary research work on the fission of uranium. (Acme photo)

The role of the slow moving neutron cannot be overemphasized. Heretofore all atomic bombardment experiments were carried on with the aid of huge equipment, cyclotrons, electrostatic generators, etc. As shown in one of the photographs accompanying this article, the cyclotron at the University of California weights 4900 tons. Now, that the mechanism involved in bombarding with slow moving neutrons is understood, such expensive electrical equipment is not necessary, at least as far as the atomic bomb is concerned.

Uranium, it is true, is a very rare element but it is quite possible that with renewed interest in the product that new uranium bearing deposits will be found. As far as can be learned, much of the raw material used in the Manhattan Project came from the pitchblend deposits near Great Bear Lake in Canada which are rich in uranium content. In this country, however, there are considerable deposits or carnotite and these also contain uranium. Carnotite is widely distributed and in certain regions this material shows the presence of some 54 per cent uranium oxide. Carnotite is found in a number of places throughout the world but none of the deposits have been exploited commercially because the pitchblend deposits in the Belgian Congo and in Canada were richer in uranium content and so the uranium market has been dominated by these two producing regions. With new, and improved means of extraction, however, it is quite probable that carnotite will become a future source of uranium products. Uranium, it must be remember is the mother of radium, therefore, all uranium deposits contain recoverable radium and this fact must be taken into consideration when the economics of the situation are involved. Because of its radium content, uranium has already played an important part in the affairs of man. Now, that we have discovered how to release atomic energy in uranium the role the element may play in the affairs of man is a matter of conjecture but it is filled with tremendous possibilities.

Ten years ago, even those engaged in atomic research would not have ventured to predict that an atomic bomb could be dropped on Hiroshima or any other place in this world in the year 1945, but it has been done nevertheless. Who is to say, then, in view of what has been accomplished in four years of intensive research and effort, that continued research and effort will not unlock the secrets of the energy in the atom so that they can be used in the production of electric power either directly or through the agency of heat? Suppose, for example, that in some fission process enormous quantities of atoms can be stripped of their electrons and that these electrons can be beamed into a collector feeding transmission lines. Such an electrical generator would render all existing power equipment obsolete overnight. Far fetched as such a supposition is today, it is not outside the realm of possibility. Long before that, however, there is an excellent possibility that atomic energy may find peacetime application through the medium of heat. Power engineers will do well not to ignore the possibility of atomic power. Atomic energy is here.

Uranium and Atomic Energy



An elementary treatment of some of the fundamental facts underlying the atomic bomb development. Most of these principles were well known as early as 1942 but they received little attention outside of the scientific world. Those who have not kept abreast of developments in atomic research will find this discussion helpful in obtaining a background against which to view the startling developments recently disclosed by the War Department. Beginning with a resume of the physics of the atom, it recounts some of the more important studies in atomic bombardment including an explanation of the process of transmutation and artificial radioactivity and then proceeds to a consideration of the fission process which is the basis of the mechanism of the atomic bomb. Finally, there is a brief discussion of the possibility of using atomic energy in the production of power.

By Andrew W. Kramer ***Managing Editor, Power Plant Engineering***

THE STARTLING DISCLOSURE of the development and use of an atomic energy bomb last month and the lifting of censorship on general discussion of atomic energy make it possible to consider the development in the light of what was known about atomic energy release before 1943 when censorship was imposed. Contrary to what the newspapers lead the layman to believe, a great deal was known about the general pattern for an atomic bomb development before 1942. As early as 1939 the process of nuclear *fission* had been demonstrated. Fission is the term applied to the splitting of the nucleus of an atom in approximately two halves. Before fission had been demonstrated, all atomic bombardment processes consisted only in knocking small portions off an atom or in synthesizing atoms by the addition of sub-atomic particles to existing atoms. By means of cyclotrons and other high-voltage electrical equipment, small charged particles such as protons, deuterons, alpha particles, etc., could be accelerated to enormous velocities and thus made to collide with atoms of various elements. If these terms, protons, deuterons, etc., do not mean anything to you, don't let it bother you just now, they will be explained later.

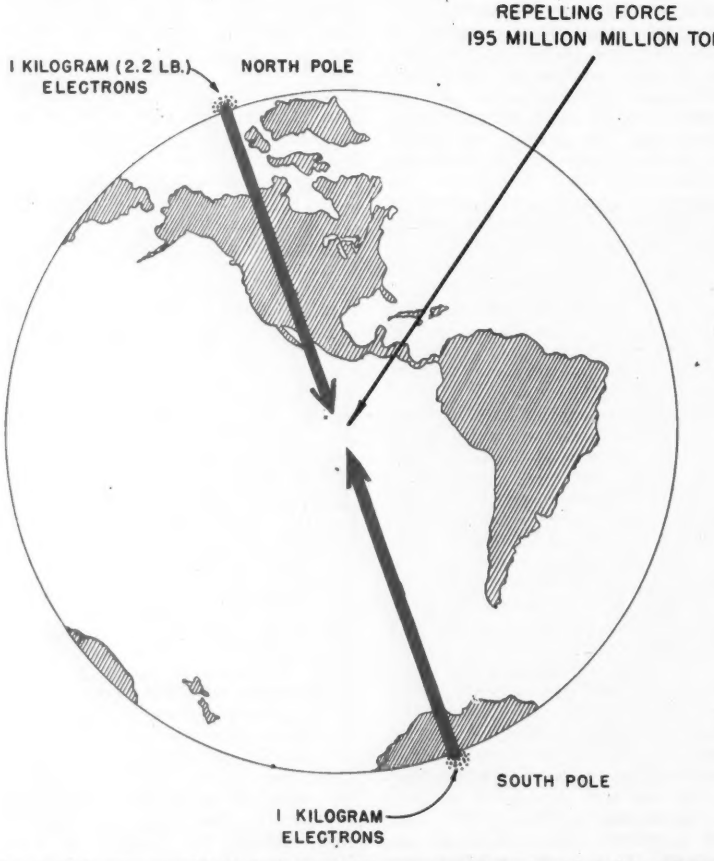


Fig. 1. If it were possible to isolate two kilograms of electrons and if these electrons were divided in two equal parts and each half placed at one of the poles of the earth, they would repel each other with a force of 195 million, million tons. (See footnote 1.)

Such atomic bombardment experiments shed a great deal of light on the structure of atoms and resulted in the realization of the age-old dream of the alchemists, transmution of the elements. In other words, by atomic bombardment processes it was possible to change the atoms of one element into those of another; for example, mercury could be changed into gold by knocking a proton out of the nucleus of an atom of mercury. The amounts of actual material involved in such transmutation processes were infinitismal but it was truly transmutation. Such transmutation processes do not always involve atom *smashing;* in many cases neutrons or protons were added to the nucleus of an atom. Although the term atom smashing was used to denote most of the early transmutation experiments the term transmutation is now used in a broader sense to describe a change in the number of protons or neutrons in the nucleus.

Basic Principle of Atomic Structure

To make these matters clear to those who have not kept abreast of developments in the field of atomic research it is necessary to present some of the fundamental facts concerning the structure of matter which

have been uncovered during the past 50 years.

As is well known, all matter, that is all solid, liquid and gaseous material, is composed of atoms. For many years it was thought that the atom was the smallest unit in nature but as electrical science developed, the atom itself was shown to be a complex system composed of still smaller elements. All atoms have been shown to be made up of a central portion called the nucleus and a number of other particles called electrons disposed in orbits around the nucleus in much the same way that the planets are disposed around the sun in our solar system. The electrons, like the planets, revolve around the nucleus at enormous speeds.

All atoms are very small and being small they are also exceedingly numerous. A single glass of water contains some 20 million, million, million, million atoms. Naturally we cannot see atoms. Suppose, however, that a glass of water were to be expanded so that it would contain the entire earth; then each of the individual atoms would be about 1-inch in diameter. If we examined these 1-inch atoms, however, it would be found that they consisted mostly of empty space, in fact we would not be able to see the particles of which the atom was made at all.

To see anything in our atom we must again expand the scale. The glass of water must be made so big that the sun could be placed at its center as a tiny pin point, and that Mercury, Venus and the Earth could easily traverse their orbits around the sun with plenty of room to spare inside the glass. On this tremendous scale we would be able to see the individual particles which compose the atoms. A single atom of oxygen in the water, for example, would be a spherical object about 10 miles in diameter. Occupying this 10-mile sphere we would find 8 electrons and at the center a single nucleus. Each of the 9 particles would be about the size of a child's toy balloon.

If, now, we examined the nucleus itself it would be found to be a closely packed group of particles resembling a cluster of grapes. It would consist of 16 particles of two types. There would be 8 particles called *protons* each having a positive electrical charge. In addition there would be 8 other particles, called *neutrons*, having the same mass as the protons, but having no electrical charge. These protons and neutrons are very much alike, and when it is conducive to the formation of a more compact and stable nucleus, neutrons are actually capable of changing themselves into protons and vice versa. There appear to be no other particles aside from neutrons and protons in the atomic nucleus. Definitely there are no electrons in the nucleus.

The number of protons in the nucleus determines the number of electrons in the orbits surrounding the nucleus. In the oxygen atom, having 8 protons in the nucleus, there are 8 electrons in the outer orbits. The electrons each carry a negative electrical charge of 1. Each proton carries a positive electrical charge of 1. Thus, the charges on the nucleus and

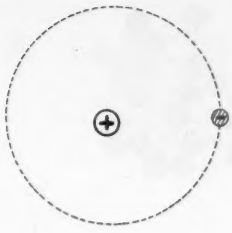


Fig. 2 (upper left). Schematic diagram of the hydrogen atom

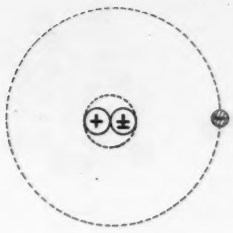


Fig. 3 (above). Schematic diagram of the atom of heavy hydrogen

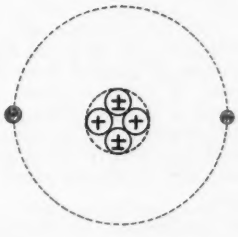


Fig. 4 (left). The helium atom has 2 protons and 2 neutrons in its nucleus

Periodic Table of the Elements

Periods	Group 0	Group I	Group II	Group III	Group IV	Group V	Group VI	Group VII	Group VIII
Type of Oxide	—	R_2O	RO	R_2O_3	RO_2	R_2O_5	R_2O_6 (RO_3)	R_2O_7	RO_4
Type of Hydride	—	RH	RH_2	RH_3	RH_4	RH_3	RH_2	RH	—
		A B	A B	A B	A B	A B	A B	A B	
		H 1 1.008							
First short period	He 2 4.002	Li 3 6.94	Be 4 9.02	B 5 10.82	C 6 12.00	N 7 14.01	O 8 16.00	F 9 19.0	
Second short period	Ne 10 20.183	Na 11 23	Mg 12 24.32	Al 13 26.97	Si 14 28.06	P 15 31.03	S 16 32.06	Cl 17 35.46	
First long period — Even Series	A 18 39.94	K 19 39 1	Ca 20 40.07	Sc 21 45.1	Ti 22 47.9	V 23 50.96	Cr 24 52.01	Mn 25 54 93	Fe 26 Co 27 Ni 28 55.84 58.94 58.69
First long period — Odd Series		Cu 29 63.57	Zn 30 65.38	Ga 31 69.72	Ge 32 72.6	As 33 74.96	Se 34 79.2	Br 35 79.92	
Second long period — Even Series	Kr 36 82 9	Rb 37 85 44	Sr 38 87 63	Y 39 88.92	Zr 40 91.22	Cb 41 93 1	Mo 42 96.0	Ma 43 ?	Ru 44 Rh 45 Pd 46 101 7 102.91 106.7
Second long period — Odd Series		Ag 47 107.88	Cd 48 112.41	In 49 114.8	Sn 50 118.7	Sb 51 121.77	Te 52 127.5	I 53 126.93	
Third long period — Even Series	Xe 54 130.2	Cs 55 132.81	Ba 56 137.37	La 57 138.9	Ce 58 140.25				
Third long period — Odd Series			The Rare Earth Elements. Atomic Numbers 59–71						
Fourth long period — Even Series					Hf 72 178.6	Ta 73 181.5	W 74 184.0	Re 75 ?	Os 76 Ir 77 Pt 78 190 8 193 1 195.23
Fourth long period — Odd Series		Au 79 197.2	Hg 80 200.61	Tl 81 204.39	Pb 82 207.22	Bi 83 209.0	Po 84	—85	
Fifth period	Rn 86 222	—87	Ra 88 225.95	Ac 89	Th 90 232.15	UX_2 91	U 92 238.17		

The number at the right of the symbol is the Atomic Number of the element, and the number below is the Atomic Weight.

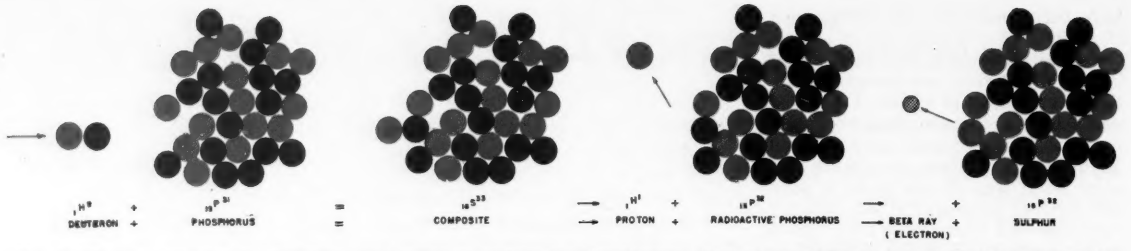


Fig. 5. Diagram showing the formation and decay of radioactive phosphorous. Protons are indicated by red circles, neutrons by black circles. (From "Atom Smashing and its Applications to Medicine" By Robley Evans, Electrical Engineering, June, 1941)

the outer electrons balance each other in a neutral atom.[1]

Isotopes

If we examine a number of oxygen atoms we will find nearly all of them alike, that is they will have 16 particles in the nucleus, 8 of them being protons and the other 8, neutrons. The atomic weight of the atom is determined by the total number of protons and neutrons in the nucleus. Thus the atomic weight of oxygen is 16.

While practically all the atoms in a sample of oxygen would be found to be alike, we would find a few rare ones that contains 17 particles in the nucleus and also a few others containing 18 particles. Like the abundant normal type each of these nuclei contain 8 protons, hence the charge on the nuclei is 8 units and therefore they require 8 electrons in the outer orbits to satisfy the positive charge on the nucleus. Since the chemical properties of an atom are determined solely by the number and configuration of the electrons, these rare oxygen atoms behave identically with those of the normal type. They are, therefore, called *isotopes*, that is, they have the "same place" in the periodic table of chemical elements. The atomic weights of these isotopes, however, is different from that of the normal oxygen atom, being 17 and 18, respectively. It must be understood that nearly all of the mass of an atom is concentrated in the nucleus.

The simplest of all atoms is that of hydrogen, the lightest of all elements. The atom of hydrogen consists of a nucleus made up of a single proton, surrounded by an orbit containing a single electron. A schematic diagram of a hydrogen atom is shown in Fig. 2.

The next simplest atom is the atom of heavy hydrogen whose nucleus consists of 1 proton and 1 neutron. Again, since there is but 1 proton in the nucleus, there is but 1 electron in the outer orbit. Its properties, therefore are the same as those of ordinary hydrogen but the atomic weight is double that of hydrogen, namely 2. Heavy hydrogen is an isotope of hydrogen. The nucleus of the atom of heavy hydrogen is called a deuteron.

The next atom in the scale of increasing complexity is the helium atom shown in Fig. 3. This consists of a nucleus having 2 protons and 2 neutrons, surrounded by an orbit in which revolve 2 external electrons. The helium nucleus of 4 particles, 2 protons and 2 neutrons, is of great importance in nuclear physics because it forms a highly stable subunit in heavier nuclei. It seems to be a building block of which larger nuclei are made. In the spontaneous disintegration of radium, for example, nuclei of helium are ejected from the nucleus of the radium atom at great speed. Under such circumstances the helium nuclei are called *alpha particles* but they are exactly the same as the nuclei of ordinary helium atoms.

This then gives us the pattern for the atoms of all of the 92 elements existing in nature. If we list all the elements in the order of their increasing atomic weights and atomic numbers (the number of protons in the nucleus) it will be found that each atom has 1 more proton in the nucleus than the element immediately below it. And, each element will have exactly the number of external electrons as there are protons in the nucleus.

Thus, we come, finally, to the uranium atom which has a nucleus consisting of 92 protons and 146 neutrons, a total of 238 particles. Because of the 92 protons the uranium atom also has 92 electrons around it in some 7 different orbits. This is the heaviest and most complex atom. Its 238 particles in the nucleus give it an atomic weight of 238 and its atomic number, of course, is 92.

The periodic table of elements is shown in the accompanying tabulation. In this table the chemical elements are arranged in 9 columns, beginning with helium in the 1st column and ending with uranium on the last line in column VI. In each case, the atomic number of the element is given at the right of the symbol and the atomic weight below.[2] The symbols in the first line refer to the types of hydrides and oxides formed and need not be given particular consideration here. In writing the symbol, the atomic number (number of protons in the nucleus) is usually written as subscript ahead of the letter representing the element, while the number representing the atomic weight, is written as an exponent. Thus, the atomic symbol for helium is written, $_2He^4$.

It would be interesting to show how the number and configuration of the electrons of the various elements account for their chemical properties but since we are not concerned with

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[1] The electrical charge of the electron and the proton are the ultimate electrical charges in nature—there can be no quantity of electricity smaller than an electron; an electron can never be divided. The electron is electricity. We speak of its as a particle but actually it is probably a center of force. Since all electrons are alike and all being of the same polarity (negative) they repel each other and with relatively great force with respect to their mass. Two electrons placed at a distances of 1 cm (⅜ in.) from each other will repel each other with a force of 1.16×19^{-19} dynes. This is an exceedingly small force in terms of ordinary units but when the size and weight of the electron is considered, it is tremendous. An idea of the forces involved between electrons can perhaps be grasped from a computation of the force of repulsion between one kilogram (2.2 lb) of electrons located at each of the poles of the earth. Their separation is about 7900 miles or 12.7×10^7 meters. The ratio of the charge to mass

$$\frac{Qe}{m_e}$$

is 1.76×10^{11} coulombs per kilogram. The force between two charges is given by the equation

$$f = \frac{Q_1 Q_2}{\varepsilon_0 d^2}$$

where ε_0 is the permittivity of free space, i. e. $\frac{1}{9 \times 10^9}$. Therefore, the repulsive force between 2 kilograms of electrons placed at opposite poles of the earth, one kilogram at each pole is

$$f = \frac{(1.76 \times 10^{11})^2}{\frac{1}{9 \times 10^9} \times (12.7 \times 10^7)^2} = 1.73 \times 10^{18} \text{ Newtons} = 1.95 \times 10^{14} \text{ or } 195{,}000{,}000{,}000{,}000 \text{ tons.}$$

[2] The periodic law or periodic system was enunciated about 1871 by a Russian, D. I. Mendeléeff. In this system, all the elements are arranged successively in the order of their increasing atomic weights and divided into eight groups, as shown in the accompanying table. When Mendeléeff so arranged the elements, a repetition of properties was observed, the elements in each group having similar properties. From 1894-1898, several new elements were discovered in the atmosphere. These were the inert gases or the Helium family. In modern tables such as shown here, these elements are placed in group O, therefore making a table of 9 groups in all, the last group having elements arranged in triads having atomic weights of nearly the same value. Hydrogen does not fit into the periodic system. By means of this law, it was possible to predict new elements. In 1871, Mendeléeff actually predicted the properties of three new elements which he called Eka-aluminum, Eka-boron and Eka-silicon. In less than 20 yr., Mendeléeffs bold prediction was complete, as all these elements were discovered and found to have almost exactly the properties predicted for them.

chemistry this aspect of the subject will not be discussed here.[3] Chemistry has to do with the forces exerted by one atom upon another. In this discussion we are concerned with the forces that exist within the atomic system itself.

Nature of Radioactivity

To explain something about the forces that exist within the atom, it is necessary to explain briefly a few facts concerning radioactivity. Radioactivity deals with the properties of a special class of substances of high atomic weight of which radium, uranium and thorium are the best known examples. These substances possess the property of spontaneously emitting radiations and particles which will penetrate bodies opaque to visible light. The emission of these radiations and particles is the result of the disintegration of the atoms of the radioactive substance into a substance of a lower order in the scale of atomic weight.

The discovery of radioactivity dates back to 1896 when Henri Becquerel found that a compound of uranium affected a photographic plate even though the latter was wrapped in black paper. It was evident that radiation of some sort was issuing from the uranium. Later on it was shown that the same radiations were capable of discharging an electrically charged body whether electrified positively or negatively. As a consequence of Becquerel's discovery, Mme. Curie made a systematic investigation of a large number of chemical elements to determine whether any of them possessed the same radioactive effect as did uranium. It was in the course of these investigations that she discovered radium, which is some two million times more active than uranium. Radium was extracted from pitchblend or uranite from which uranium is also extracted.

Later on, it was shown that there were actually three different types of radiation or particles issuing from radioactive substances. There was one type which proved to be an x-ray of very high frequency. This was called the gamma ray. Next, there was the beta ray which was shown to be a stream of electrons. The third type of radiation also proved to be a stream of particles but in this instance the particles were alpha particles, that is *helium atom nuclei*. Thus, it seemed that these radioactive substances were disintegrating partially into an element of very much lower atomic weight. This was the first time that anyone had ever observed the actual transmutation of one element into another.

Another startling thing about the radioactivity process was the tremendous energy involved in the release of the alpha particles and the electrons forming the beta rays. The alpha particles were shot out of the radioactive elements at enormous velocities, some of them moving faster than 12,500 miles per second and thus would allow them, if unimpeded, to go around the earth in less than two seconds. The energy of any swiftly moving nuclear particle is usually expressed in millions of electron volts. The electron volt is the kinetic energy that an initially stationary electron acquires by moving through a potential difference of one volt. The energy of the common alpha ray is about 5,000,000 electron volts which is vastly greater than the kinetic energy obtainable by any known chemical or mechanical means. The energy of each atom in a high speed rifle bullet is less than 1/10 of an electron volt. Thus, the alpha particle which is spontaneously shot out of a radium atom has some 50,000,000 times the kinetic energy of the atoms in a rifle bullet.

This manifestation of enormous energy gave the clue to the vast forces which hold the component parts of an atom together and it furnished the incentive for scientists to find some way of releasing and recovering the energy of the atom and applying it to useful purposes.

Subsequent investigation disclosed a great variety of new facts concerning the structure of the atom and many methods were evolved in attempts to "smash" the atom in recent years. At first, scientists tried to use the high speed alpha particles from radium and other radioactive elements to bombard other atoms. To smash atoms more abundantly than is possible with alpha particles alone it is desirable to put simple atomic nuclei such as those of hydrogen (proton) and heavy hydrogen (deuteron) into high speed motion. This can be accomplished by producing *ionized* hydrogen atoms, that is, hydrogen nuclei, in a hydrogen arc, and then accelerating the protons or deuterons so produced through a vacuum tube across which is impressed a potential of several million volts. Various types of electrical generators have been developed in the last twenty years for effecting such accelerations so that particles having energies above 10,000,000 electron volts have been easily available and in quantities far greater than could be realized in the alpha rays from all the refined radium in the world. The cyclotron is the most effective machine so far produced for accelerating electrified particles in this manner.

Artificial Radioactivity

Among the first of the interesting facts disclosed by such atomic bombardment experiments was the realization of artificial radioactivity, that is, the transmutation of the atoms of common stable elements into unstable atoms exhibiting radioactive properties. Thus by bombarding common salt it has been possible to produce radioactive sodium chloride. Such radioactive salt is exactly the same as ordinary salt, except that for a few hours it shoots forth rays and particles in the same way that atoms of radium do. For a short time the nucleus of the atom of salt is rendered unstable and then, upon emitting an electron or a proton, it once more becomes stable.

To explain this in greater detail let us consider an atom of phosphorus. Phosphorus has an atomic number of 15 and an atomic weight of 31. Thus, the nucleus contains 15 protons and 16 neutrons. Also, there are 15 extranuclear electrons but these need not be considered here. This atom is the only stable isotope of phosphorus occurring in nature. It is possible, however, to make an *unstable* type of phosphorus by adding 1 neutron to the nucleus. This can be done most effectively by bombarding ordinary phosphorus with deuterons. The nuclear reaction which takes place is shown in Fig. 5. Here, it will be noted, a deuteron bombards a phosphorus nucleus, combining with it momentarily to form an unstable nucleus with an atomic number of 16 and an atomic weight of 33. This breaks up practically instantly with the emission of a proton, thus leaving the final heavy nucleus with 1 more neutron than is contained in the ordinary stable phosphorus. The new product is radioactive phosphorus and its atomic weight is 32.

If now, we examine a list of the stable isotopes, it will be found that there is a stable configuration of 32 particles in nature which is an isotope of sulphur. This has an atomic number of 16 which means that there are 16 protons in the nucleus. It is evident that if 1 of the neutrons in the heavy radioactive phosphorus produced as just described, could transform itself into a proton, it could realize stability because the new nucleus so formed would be identical with one of the known stable isotopes of ordinary sulphur. This, in fact, is exactly what happens. One of the neutrons in the nucleus of the radioactive phosphorus changes into a proton. The fundamental physical laws of conservation hold among the nuclei, consequently at the same time that 1 unit of positive charge is created in the form of a new proton, one unit of negative charge also must be created. Thus, there is produced at the boundary of the nucleus a new electron, and this electron is fired away from the nucleus with great velocity because of the excess of energy which is released from the nucleus as it becomes more stable in becoming sulphur. The rapidity moving electron is, of course, the beta ray.

The radioactive phosphorus, like all other such artificially produced isotopes has a comparatively short life before it spontaneously changes into

[3]For a complete discussion of the nature of chemical action as related to atomic structure, see Electricity—What it is and how it acts, Volumes 1 and 2, by A. W. Kramer.

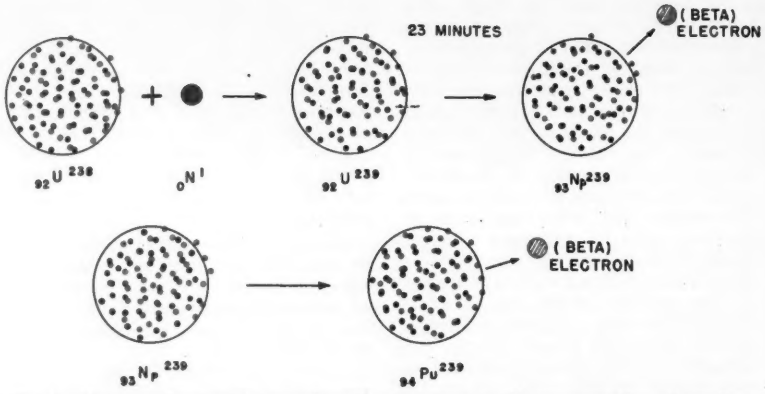


Fig. 6. Diagram showing the transformation reactions in the transmutation of uranium 238 into neptunium and plutonium. (Based upon "Uranium and Atomic Power" by De Ment and Dako Chemical Publishing Co., Inc., 1941

sulphur. In a given quantity of such phosphorus, 35 out of every million nuclei undergo the spontaneous transformation into stable sulphur each minute. This means that half of any given stock of such radioactive atoms will remain unaltered for 14 days.

The electrons which are shot out from the decaying radioactive nucleus have velocities nearly equal to that of light and their energies in the case of radioactive phosphorus measure up to 1,700,000 electron volts. In their passage through matter these electrons collide with the atomic electrons of the atoms through which they pass and are slowed down and finally come to rest.

This process of inducing artificial radioactvity in normal, stable atoms was discovered in 1934 by M. and Mme. Joliot-Curie, the latter, the daughter of Mme. Curie, the discoverer of Radium. Naturally, it developed a great deal of interest throughout the scientific world and soon, practically all of the commonly known elements had been rendered radioactive in this way. It immediately made possible a new and valuable method of medical diagnosis — the tracer method — which greatly promoted studies in plant and animal metabolism.

Nuclear Fission

In the meantime other interesting facts were being disclosed. In 1934, also, Professor Fermi and his coworkers showed that the very heavy elements, uranium and thorium, also are capable of capturing neutrons and becoming highly radioactive. Then, suddenly, came the announcement that Fermi had produced a new element—an element heavier than the uranium atom with an atomic number of 93 and an atomic weight of 239. This *transuranium* atom, so called because it had an atomic number and an atomic weight greater than the atomic number and atomic weight of the heaviest and most complex element found in nature, was shown had a life of about 23 minutes and then it spontaneously changed into still another atom with atomic number 94 and atomic weight 239. At the same time, other investigators demonstrated the presence of elements of about half the atomic weight of uranium among the products of such bombardments. This latter fact was startling because it seemed to indicate *for the first time, that atoms were actually being* split into two approximately two equal parts; in other words, *fission* had been accaccomplished. Remember, up to this time, small parts had only been knocked out of atoms with a great expenditure of energy. Now, the atoms actually was being split.

The news shot through the scientific world like an explosion. Other investigators repeated the experiments with the same results. All the isotopes of uranium, that is U234, U235, and U238 were investigated, and in April of 1940, Dr. Nier of the University of Minnesota and also Drs. Booth, Dunning and Grosse of Columbia University succeeded in separating sub-microscopic quantities of these isotopes by means of the mass spectograph. It was discovered that only the medium mass isotope, uranium 235 was subject to *fission* when bombarded by neutrons. Uranium 238 also absorbed neutrons but in this case it was transmuted to element, $93^{(239)}$.

The two transuranium elements, that is $(93)^{239}$ and $(94)^{239}$ were named neptunium and plutonium respectively. The reaction involved in the synthesis of these elements is shown in an accompanying diagram. It will be noted that one of the neutrons in the nucleus of the $(93)^{239}$ changes into a proton with the expulsion of a (beta) electron, thus forming $(94)^{239}$.

The really startling discovery, however, in these investigations was the fact that when fission occurred in the case of U235, the products of the fission escaped with such violence that they traveled a distance of several centimeters from the target in which they were produced. This was evidence of enormous energy release—energies of the order of 200 million electron volts, which is equivalent to four trillion, six hundred billion calories per gram of uranium! This is an amount of energy almost staggering to the imagination. Curiously enough, the release of this energy seemed to be accomplished only by bombardment with relatively *slow moving neutrons,* neutrons having kinetic energies less than 25,000 electron-volts. Indeed, in some instances, it appeared that neutrons having only 5 electron-volts of energy were capable of producing fission with a consequent energy release of over 150 million electron-volts. All of this indicated that the energies released in the fission of uranium are more than 40 million times greater than released in the explosion of one molecule of TNT.

The significance of these discoveries was clearly evident to the scientific world as early as 1940. For many years scientists had thought about, and discussed the possibilities of utilizing the tremendous sources of power locked up in the atoms and now for the first time there was evidence that this energy could be released. True, the amounts of energy involved in these experiments was infinitesmal but the mechanism had been disclosed and all that remained was to find methods of performing the processes on a large scale. By 1941 the nature of the transformation reactions was known with a considerable degree of accuracy. When an atom of uranium 235 is split in the fission process, it forms at least two atoms of lower atomic weight. Thus, uranium may be broken up into boron, krypton, rubidium, etc. The process of fission is complex. The unstable particle formed by the capture of a neutron by a uranium 235 nucleus bursts in one trillionth of a second into at least two atomic particles. In addition to the atoms of lower atomic weight formed, the process of fission is also accompanied by the ejection of many more fast-moving neutrons than were captured. These neutrons can, in turn, effect fission in other uranium atoms which means that a chain reaction can be set up which will continue as long as there are any uranium atoms remaining. Of course, the time element is such that such a chain reaction would take place instantly with explosive violence. This, basically, is what takes place in the atomic bomb which has been developed as a result of all these investigations.

Thus, as early as 1941, the pattern for the atomic bomb was reasonably well known. Both in this country as well as in England and also, no doubt, in Germany, the possibility of developing an atomic bomb were widely recognized by scientists. The principle problem which remained to be solved was that of producing enough uranium 235 to make such bombs practicable.

As indicated in a preceding paragraph, there are three common isotopes of uranium, the most common being uranium 238. The other two

are U234 and U235. In any sample of uranium, 97 per cent of the atoms will have a mass of 238. Quantitative determinations show that for every 139 atoms of uranium 238 there is one atom of uranium 235, also that there is only one atom of uranium 234 in every 17,000 atoms of uranium 238.

As has been pointed out, Dr. A. O. C. Nier at the University of Minnesota was the first to isolate a minute quantity of U235 and to prove conclusively the fission of uranium. His method of separation of U235 was by means of the mass spectograph method which yielded an almost infinitismal quantity, and was a very costly procedure; in fact to produce 1 lb of U235 by this method would require some 75,000 years. Other methods were soon developed which yielded larger quantities. The thermal diffusion method for example indicated that the separation process could be speeded up by a factor of 11,000. Even this method was slow, however, and even before 1942 a number of different methods of effecting separation were under investigation.

At best, however, the prospects of realizing workable amounts of uranium 235 was not encouraging. In the meantime, that is, while the work on U235 had been proceeding an important discovery had been made. It was found that the new element, plutonium Pu 239, also was subject to *fission* by slow moving neutrons. As in the case of U235, when the nucleus of an atom of plutonium was bombarded by a slow-moving neutron, the nucleus of the plutonium atom split in two parts producing atoms of approximately half the atomic weight of the parent atom. Also, the split was accompanied by the release of enormous energy and additional free neutrons. Thus plutonium could be used in an atomic bomb in exactly the same way as uranium 235.

This immediately offered new possibilities. The prospect of getting large quantities of plutonium were much better than with uranium 235 since the addition of a neutron to each atom of uranium 238 would result in the formation of an atom of plutonium. Since there was much more uranium 238 than uranium 235 in nature, it seemed that the solution to the problem lay in the use of plutonium.

It was evident from the beginning that the large-scale production of plutonium would have to be accomplished by a controlled, chain reaction process. Neutrons would have to be produced from as element such as beryllium and the speed of these neutrons would have to be reduced by a neutron velocity moderator of some kind before they could be effective in transmuting U238 into Pu239.

As early as the fall of 1942 an attempt had been made to build the first self-sustaining, chain reaction pile, designed on a lattice principle with graphite as the neutron velocity moderator and lumps or rods of uranium metal or uranium oxide as the reacting units. The reaction involved indicated great energy release, in fact, to produce a kilogram of plutonium a day, a chain reacting pile would evolve energy at the rate of 500,000 to 1,500,000 kw.

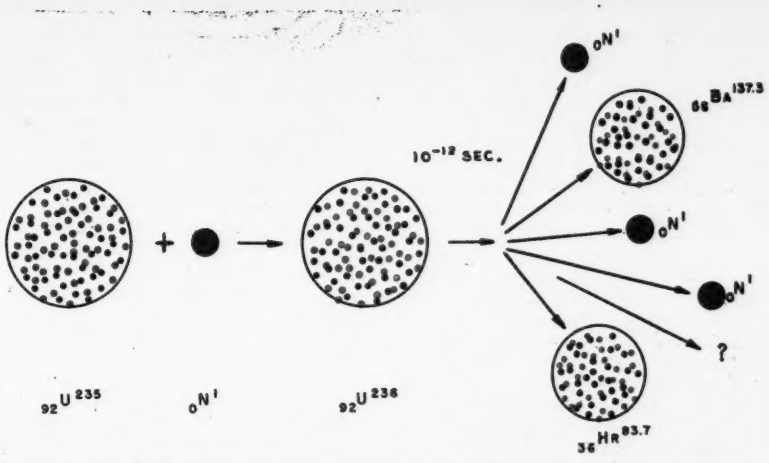


Fig. 7. Illustrating the fission of uranium 235 by the addition of a neutron

So far, little has been said regarding the mechanism of producing fission other than that it is done by the bombardment of the uranium atom by a neutron—a slow moving neutron. The latter fact is of great significance. In most of the early work on atomic research the aim was to use extremely high speed particles. In the early work the particles were usually charged particles, i.e., protons or helium nuclei. The difficulty in using such charged particles is that they are repelled by the positive charge of the nucleus of the atom, and it is only when they are travelling at extremely high velocity that there is even a chance of them colliding with the nucleus of an atom. With the discovery of the neutron by Chadwick, however, the repelling force of the nucleus ceased to be a factor. The neutron carries no electrical charge and, therefore, it can approach the nucleus of an atom even at very slow speeds.

This, then, provides a simple way of setting off a chain reaction. Suppose we have a quantity of U235 or Pu239 suitably associated with a neutron velocity moderator such as graphite. Once a few slow-speed neutrons were introduced into the mixture, the neutrons would cause fission in some of the atoms of U235 or Pu239 and in the fission process other neutrons would be liberated. After passage through the moderator material, these neutrons would produce further fission and so the chain reaction would continue. In such a mixture it would not even be necessary to provide the initial neutrons because at any point on the earth's surface enough neutrons are produced by cosmic ray action to initiate the process.

The question, therefore arises, how could such a mixture of uranium and moderator be prevented from exploding before the desired time? Curiously enough, nature provided a very simple means which has to do with the size of the mass involved. Until such a mass of uranium and moderator reaches a certain critical size more neutrons escape from the surface than are produced inside and under these conditions the chain reaction will not sustain itself. Above the critical size, however, less neutrons escape than are formed in the mixture and then the chain reaction proceeds. Further information on this phase of the problem will be discussed in a subsequent article but it can be said here that this principle having to do with size was a vital one in the development of the atomic bomb.

The principle involved in the action of the moderator in slowing up the neutrons is interesting. To slow up high speed neutrons it is merely necessary to make them travel through a compound containing hydrogen atoms such as water or paraffin. As will be recalled, the neutron has the same mass as the proton (the nucleus of the hydrogen atom). Thus the proton can absorb the greatest amount of the energy of a fast moving neutron. To explain this more clearly, consider a moving billiard ball colliding with a stationary ball. If the collision is direct the stationary ball will absorb practically all of the energy of the moving ball and will travel at approximately at the same speed as the ball which hit it, while the latter will be stopped dead. If the same experiment is attempted with a billiard ball and a marble, even though the marble is set in motion by impact, it can absorb only a small fraction of the energy of the billiard ball and the latter will continue at practically the same speed after the collision as it did before.

On the other hand, if the stationery ball were a cannon ball, it would scarcely move, while the billiard ball would bounce back in the opposite direction from which it came with practically the same speed it had before the impact. Thus it will be seen that the most effective energy transfer takes place when the two objects have nearly the same mass.

This, then, is why water or paraffin is so effective in slowing up the high speed neutrons produced, say, by bombarding beryllium with the rays from radium. And this provides a method of controlling the action we have been considering. A small amount of radium, mixed with beryllium and embedded in a block of paraffin will suffice as a source of neutrons for bombarding uranium. It will be evident, however, that the neutron produced in the fission of one uranium atom must also be slowed up before they can be effective in the fission of other uranium atoms and here, again, the use of water or other hydrogen compound suggests itself.

This also suggests a means for utilizing the atomic energy in other ways than in causing the terriffic explosive force witnessed in the atomic bomb. Suppose that a dilute mixture of uranium 235 could be immersed in water. Upon bombardment by slow neutrons, the entire mass of uranium would become incandescent by virtue of the heat released. This would turn the water into steam which could be used to run an engine or turbine. In other words, the uranium would serve as the fuel for making steam. In considering such a scheme a very interesting fact discloses itself. Unless such a process could be controlled it would not be of much use but it so happens that water in the form of steam does not slow up neutrons because in the form of steam the oxygen and hydrogen atoms are very much farther apart than they are in the form of liquid water; hence as soon as the water in contact with the uranium turned to steam there would be a diminution in the fission process and it would not be accelerated until more water was added.

These facts are of tremendous importance because it suggests an entire revolution in our power producing processes. It must be understood that only a very small amount of uranium would be required in such a process. A single pound of Pu239 or U235 would provide about as much energy as could be produced by burning 2500 tons of coal. Thus, a single gram of uranium might heat an ordinary house for a period of an entire lifetime. An automobile, driven by a steam engine with the elimination of all gears and clutches, would be built at the factory and charged there with a gram or two of U235 and this would run the car throughout its entire life.

At present no one can say with certainty that these things will be fully realized but the fact that the atomic energy has been attained in the atomic bomb makes all of them quite possible. Just how much a pound of Pu239 costs at the present time is a military secret but the very fact that enough of the material has been produced to make the bomb possible makes it necessary that we give attention to these facts. The implications of the development are so enormous that scarcely anything that arises in our imaginations can be disregarded.

What has been considered in this article is mostly in the light of what was known in 1942. The actual process involved in the mechanism of the atomic bomb may be somewhat different than that suggested but the basic principles discussed here, hold.

The production of plutonium on a large scale was evidently the problem of major importance which had to be solved in the course of the "Manhattan" project and no doubt much of the research, effort and perhaps most of the cost was expended on that phase of the problem. The project stands without question as the most magnificent in the whole history of science. To magnify an experiment that was based on the use of only a few micrograms of material into plants the size of those at Oak Ridge and Pasco required a degree of confidence and daring, the like of which has never been approached in any field. That it was successful is eloquent testimony to the skill of the scientist and to the soundness of modern scientific methods. If the politicians and the statesmen could in even small measure, accomplish their function in society as well, the possibility of lasting peace in this world would be assured.

Even if nothing more is accomplished by the expenditure of the two billion dollars which the project cost, than the production of the two bombs dropped on Japan, the effort would be amply justified by the results it produced.

As to the implications of the atomic energy release in the bomb upon the power industry, there is some disagreement. Some scientists do not believe that it can ever be applied in the production of power for peacetime purposes. Others are much more optimistic. Prof. H. D. Smyth, chairman of the physics department at Princeton University, says, "There is good prabability that nuclear power for special purposes could be developed within ten years and that plentiful supplies of radioactive materials can have a profound effect on the treatment of certain diseases in a similar period."

The treatment here, has been, of necessity, somewhat sketchy but it will provide a background against which this development can be considered. Further disclosures regarding the atomic energy development will be presented in future articles in subsequent issues.

ATOMIC BOMBS AND THE FUTURE

by Dr. Edward U. Condon

Associate Director Westinghouse Research Laboratories
East Pittsburgh, Pa.

EVERYONE today is speculating on what the future of the atomic power will be, now that it has been revealed that the atomic bomb is a reality—a potent weapon in our hands which we all hope will end war among nations. We will then be faced with the opportunity to build a world order, and with the horrible prospect of man's total annihilation as the alternative which confronts us if we fail. From what has been said of the potency of this weapon, total annihilation seems to be no exaggeration of the consequences of a war in which both contestants started with a good supply of these bombs.

It is evident that at present nothing more is to be told of the technical details beyond the sketchy accounts we have been given of the magnitude of the project, of the general nature of the first test in New Mexico and of the enormous potency of the new weapon. But we all must consider in sober earnestness some of the implications of the existence of this weapon.

It represents a culmination of researches in atomic structure which have been carried on throughout the world during the past fifty years. It is important for us to realize the international character of these studies. More than fifty years ago the foundations of modern atomic science were laid in the discovery of the periodic system of the elements by Mendeleef, a Russian, and Russian scientists in large numbers have distinguished themselves in this field ever since. In the nineties the foundations of electronic science were initiated in England through the studies of J. J. Thomson and a decade later by Ernest Rutherford, a New Zealander who pioneered in understanding the fundamental nature of

radium and natural radio-activity. In the early period France was represented by Madame Curie, who has had a long line of distinguished successors, including her daughter, Irene Curie, and her distinguished husband, F. Curie-Joliot, who, I am told, secretly carried on researches on atomic power during the German occupation of France. There is not space here to give names; in the modern period since 1930 progress in this field has been made by Russians, Americans, English, Danes, Germans, Italians, Japanese and others.

We in America have done some fine work in this field of which we have a right to feel proud. We have a right to feel proud in the spirit that we have been able to play a part in developing man's growing mastery over the forces of nature, and in the faith that by us this weapon will be used righteously in the preservation and further development of freedom everywhere. But we have no right to feel the slightest tinge of prideful superiority over the scientists of other nations who have contributed so much to the background science of the atomic bomb.

Although there is a natural continuity about all scientific development, the decisive discovery which made the atomic bomb possible was made in late 1938 in Germany. It was not made by persons working with military objectives in view. It was made by persons who were engaged in fundamental research in physics and who were working in the spirit of free international collaboration that has characterized scientific progress in the modern period. The implications of the discovery were soon realized by physicists, throughout the world, but with the coming of war it became an important matter of national policy in each of the countries that the work in this field be greatly, speeded up and that it be carried on under great secrecy.

The basic discoverey was made in Germany, and the basic scientific facts were disseminated throughout the world before wartime secrecy policies were established. Therefore, although we may not know in detail what is going on elsewhere, we know that the scientists of every country had at the outset an equal access to the basic facts. In Germany, in France, in Italy, in Russia, in Japan, in England, in America—anywhere where there are physicists in laboratories it was possible for this work to go ahead.

However, this was a big job and it took many men and vast industrial resources as well as basic scientific knowledge and understanding. The Anglo-American coalition has done it first and that is important and of immediate great value in the war. We not only know how, but we have plant capacity and can produce atomic bombs. It is a great achievement scientifically and a great achievement industrially. It is almost inconceivable that so much has been accomplished since January, 1942, when the large program was launched.

But before we get too prideful about that, let us reflect that we do not know yet how near the Germans came to getting there first nor do we know what progress the Japanese have made. Yes, it is true, there are some first-rate scientists in Japan and a great industrial capacity there and in Manchuria, and we cannot dismiss the possibility that they may be well along.

We cannot assume for a moment that we will have an Anglo-American world monopoly on the use of atomic energy for more than a few years at the most. But even let us suppose that no one had hitherto started this work besides the Anglo-American coalition and the Germans, who are now under our control. We accomplished this in less than three years at a cost of approximately two billion dollars. There is no denying that we have many first-rate physicists and a marvelous industry—just the right combination for this job. However, the other side of the picture is this: what we can do in three years, others can do in perhaps five or six years, especially with the knowledge which everyone now has that it is not a gamble but that it surely can be done. As to the cost of two billion dollars, it must be remembered that only a small part of the figure represents research costs, the rest went for industrial plants for making the bombs. And it also must be remembered that the costs are high because of the inevitable waste associated with extreme urgency. For example, much money was spent following up simultaneously several alternative lines of investigation when, under peacetime conditions, only one at a time would be followed and solutions found without the expense of developing all the alternatives.

But finally it must be remembered that two billion dollars is not a very great sum of money in terms of budgets of major powers. It is, for example, considerably less than the loss to American investors on defaulted German bonds which were floated between World War I and World War II. It is moreover less than 2 per cent of the national annual income when we operate our industrial plant at maximum capacity as we have been doing in recent years.

I am not advocating that, therefore, we should freely tell all of the technical results of our program. I am, however, making the point that we cannot assume that we shall have the military advantage of exclusive possession of this weapon for more than a few years. We must not develop a Maginot Line mentality in which the atomic bomb is our Maginot Line.

Returning to the question of the cost, there is another point which is even more important than those already made. It cost us two billion dollars to do the job the way in which we did it. And here I am not referring to the costs of multiple solutions of some problems nor of the costs of rush construction under war conditions as compared with more economical peacetime methods. I am rather referring to the fact that we do not know very much about this subject yet. We did the job in the way we saw we could, with emphasis on speed and without regard to cost.

There may be vastly simpler ways of doing this than we have used. Already, I suspect, a large part of the plants we have built are obsolete. We know so little about this subject that we do not know for sure that the making of atomic bombs requires the vast industrial plants which we have erected for the purpose.

It is conceivable, for example, that in the years to come some small group of Nazi scientists working in some remote haven, say in South America or perhaps in Spain, may find a way to do this thing with only small, inexpensive and inconspicuous equipment. That is one of the most important reasons why we must continue the most careful and thorough investigation of atomic physics and why we must set up a world order that really covers the entire world—one which does not leave us unaware of what is going on in any remote valley in Spain. With this power in man's hands, world cooperation must come. It is peace or death.

Let us recapitulate:

(a) Man is now in possession of a new kind of energy source vastly more powerful than anything used before.

(b) It is the culmination of a war effort, built on decades of free international exchange of scientific knowledge.

(c) While we produced the atomic bomb first, other national groups working independently may not be far behind right now.

(d) It is a certainty that, spurred by the knowledge that the thing can be done, any major national group could, without aid from us, and without benefit of espionage, at least do what we have done within a few years.

(e) Our knowledge of this field is very incomplete and it may be possible to do what we have done in vastly simpler ways than the only way known to us at present.

Therefore,

(1) We must set up a world order including all peoples to make certain that atomic power is used only for peaceful purposes, and

(2) We must continue intensive cultivation of fundamental research in atomic physics to the end that we may really know all about this tremendous new source of power so that we may apply it to useful purposes in the years of peace that lie before us.

New Power Plant for Standard's

Primary function of plant to supply steam to refinery of Louisiana Division, Standard Oil Company of New Jersey . . . Reasons for design of various plant elements, methods of co-ordinating them . . . Electric power generation a by-product . . . No returns from refinery, hence plant requires approximately 100 per cent make-up . . . Three gas-or-oil fired boilers supply up to 750,000-lb-per-hr of steam at 650-psig, 750-F . . . All steam supplied to refinery at 140-psig through 15,000-kw turbine or 650—140-psi reducing station or both in parallel . . . Mississippi River water for make-up clarified and softened . . . Condensing heaters produce high-quality service, chemical plant and desuperheating water . . . Semi-housed plant construction . . . Generation at 13,800-v, direct connection to refinery 13,800-v distribution system . . . Part II will discuss the heat balance and operation.

Part I

FOR SUPPLYING process steam at 140-psi to a refinery, at the same time generating by-product electric power in an amount corresponding to the process steam demands, a new power plant, known as the SPLA Boiler and Power Plant, has recently been built by the Louisiana Division, Standard Oil Company of New Jersey at Baton Rouge, La.

General Plant Characteristics

Designed by Stone & Webster Engineering Corp., the installation contains three 250,000-lb-per-hr steam generating units and one 15,000-kw non-condensing turbine generator. Mixed natural and refinery gas or oil are the fuels burned. The three steam generating units together have a total continuous full load capacity, with either fuel, considerably in excess of the maximum steam requirements of the main turbine generator and steam-driven auxiliaries. However, the principal objective of the plant is to produce process steam and the electrical output is in a sense a by-product, hence the normal relationship between boiler and turbine capacity does not hold in this instance.

In general, the entire steam output, except the portion used by steam-driven auxiliaries, is available as process steam, after passing either through reducing stations or through the main turbine, which exhausts at process pressure, or through both in parallel. All steam is consumed by the refinery and no drips are returned, hence make-up is almost 100 per cent.

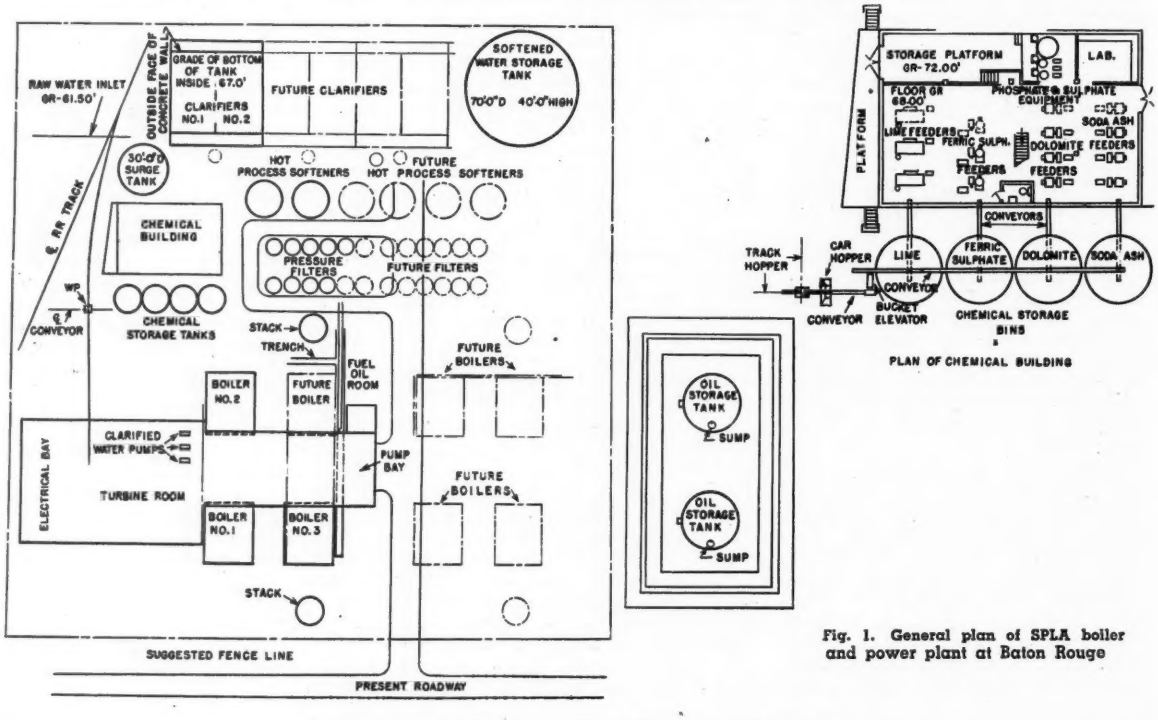


Fig. 1. General plan of SPLA boiler and power plant at Baton Rouge

Baton Rouge Refinery

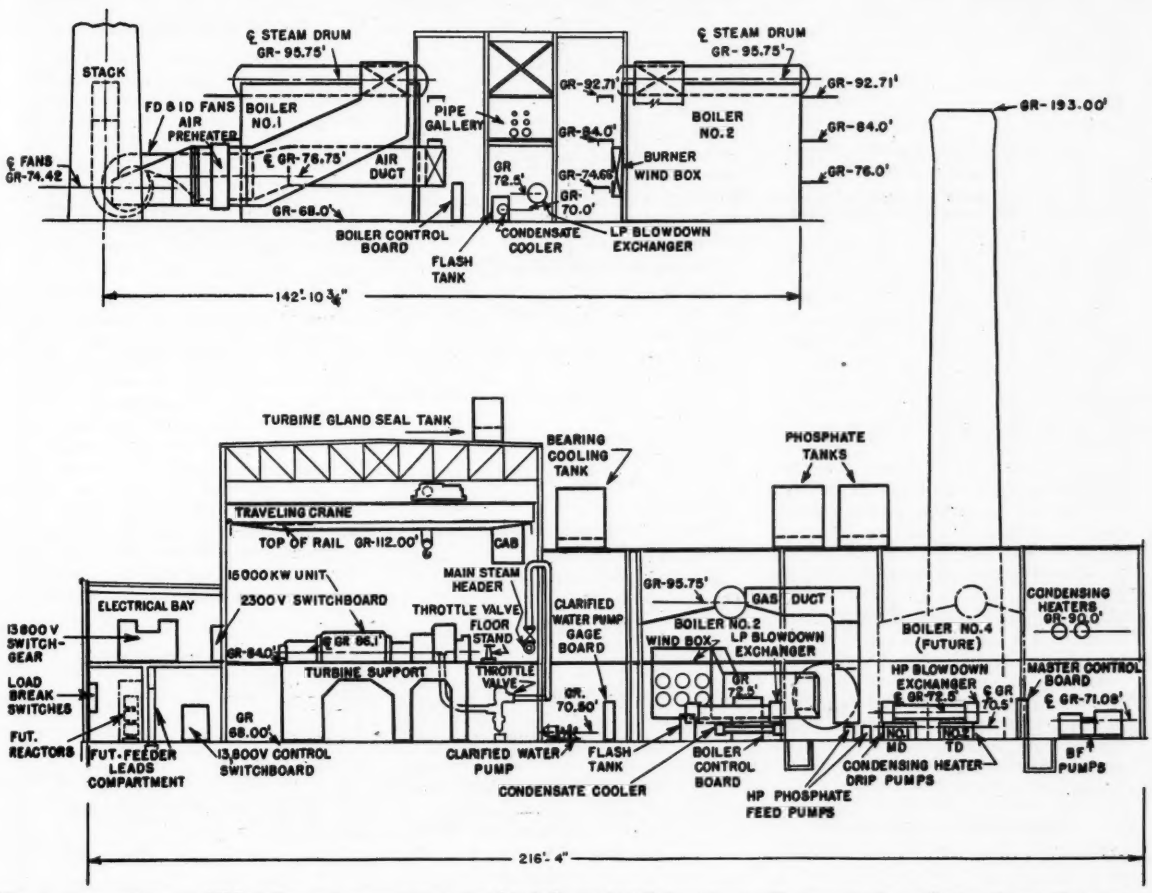


Fig. 2. Cross-sections of SPLA boiler and power plant, showing boil ers installed outdoors with covered pipe gallery and operating space betwee n them

The objectives underlying the design of the plant are, in order of importance: (1) safety; (2) service reliability; (3) operating simplicity; (4) economy of critical materials; (5) low cost of production. In connection with (5), every effort was made to balance installation cost and maintenance expense to give lowest overall cost of steam and electricity consistent with the first three objectives.

Outstanding Design Features

As shown in the drawings and described in detail below, the outstanding features of the plant are:

1. Generation of steam at 650-psi, 750-F and use of non-condensing, non-extraction turbine generating electric power from this steam and exhausting it at 140-psi to process steam lines. Amount of generation is governed by steam flow required to maintain constant turbine exhaust pressure, any process steam deficiency being made up through a 600-to-140-psi reducing and desuperheating station.

2. Operation with approximately 100 per cent make-up, necessitating a water clarifying and softening plant of 100,000-gph capacity, treating Mississippi River water for feeding the boilers. No drips are returned from the refinery.

3. Feedwater heating system carried out in five stages involving water softeners, blowdown heat exchangers, condensing heaters.

4. Use of condensing heaters for producing high quality water for various plant services; desuperheating water supplied from these heaters, to prevent carry-over of solids to process equipment.

5. Complete automatic combustion control system for boilers, with gas mixing control for natural and refinery gas.

6. Maximum use of steam turbine driven auxiliaries, all exhaust steam being used for feedwater heating.

7. Pressure reducing and desuperheating station including 3 parallel circuits to give highest flexibility in handling steam flow variations in parallel with the main turbine, with precautions to prevent overpressure by shutting off fuel supply.

8. Heat balance in which process steam production is the governing factor rather than power generation. Hence the heat balance is affected very little by the operation or non-operation of the main turbine, but very much by the operations of auxiliary drive turbines, condensing heaters, and of the desuperheaters through which process steam is supplied, to prevent carryover into refinery process equipment.

9. Generation of electricity at 13,800-v and direct connection without transformation to the 13,800-v refinery electrical distribution system.

10. Semi-housed construction of plant with boilers in the open, an enclosed pipe gallery and operating

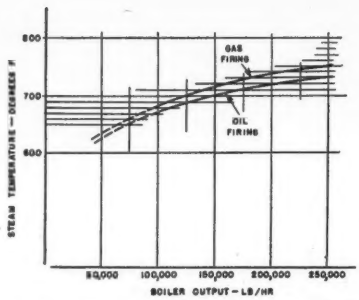


Fig. 3. Curve of steam temperature variation at boiler superheater outlet, SPLA plant

space between them, an enclosed turbine room and most of the water treatment plant installed out of doors.

The basic cycle arrangement of the SPLA plant is shown in Fig. 6 while Fig. 8 (to be shown in Part II in a later issue) shows a heat balance diagram for a typical high boiler and plant steam output. Under normal operating conditions, steam pressure in the main steam header near the turbine throttle is held practically constant by the automatic combustion control system. Steam temperature, however, will not be controlled and is expected to vary from 700-F at half load on the boilers to 750-F at full boiler output. Expected variation of steam temperature with load is shown in Fig. 3.

Details of equipment are given in the accompanying list of equipment. A brief description of the principal features of equipment and some discussion of the heat balance are given below.

Steam Generating Equipment

Steam is generated by three 20,750-sq-ft integral furnace boilers of standard design, each equipped with a 12,230-cu-ft completely water-cooled furnace. Each unit is equipped with six steam-atomizing, combination gas and oil burners located in the front furnace wall and firing horizontally. A 2,763-sq-ft inverted loop tube superheater is located in each unit between first and second boiler convection passes. No economizers are included.

One regenerative type air preheater, mounted independent of each boiler, reduces flue gas temperature to 352-F at full load with gas firing while heating air for the burners to 460-F.

The boiler units are designed to deliver steam at the superheater outlet at 650-psig. General operating conditions are:

Steam pressure at turbine throttle —600-psig min.

Steam temperature at turbine throttle—725-F.

Back pressure at turbine exhaust—140-psig.

Steam pressure, superheater outlet —650 psig.

Steam temperature superheater outlet—750-F max.

Steam pressure, process lines—140-psig.

Steam temperature, process lines—440-F.

Tables I and II show expected performance of boilers and turbine-generator.

Turbine Generator Equipment

The main turbine unit is a non-extraction, non-condensing machine, designed for back pressure operation at approximately 141-psig when supplied with 600-psig, 725-F throttle steam. The turbine drives a direct-connected 15,000-kw, 0.8-pf, 18,750-kva, 3600-rpm, 3-phase, 60-cycle, 13,800-v air-cooled generator, with direct-connected 80-kw main exciter and 2.5-kw pilot exciter.

The turbine is equipped with an oil-operated adjustable back-pressure governor that admits steam to the turbine in sufficient quantity to maintain a predetermined back pressure at the turbine exhaust flange, the electrical output of the machine varying with the steam flow variations. A manually operated load limit valve is also provided to limit the steam admission to the turbine when it is on back-pressure control. A speed-responsive governor with a synchronizing device and an emergency governor set to trip the throttle at 11

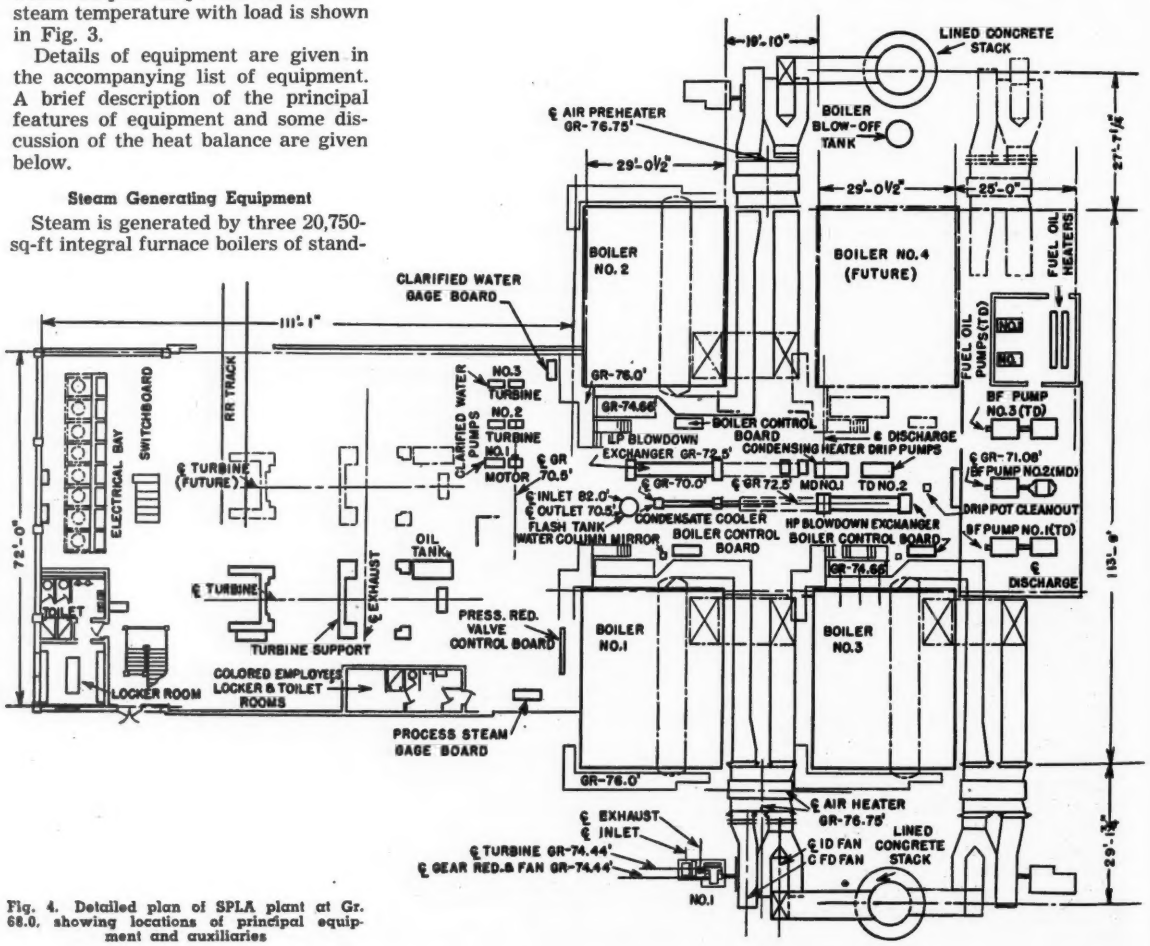
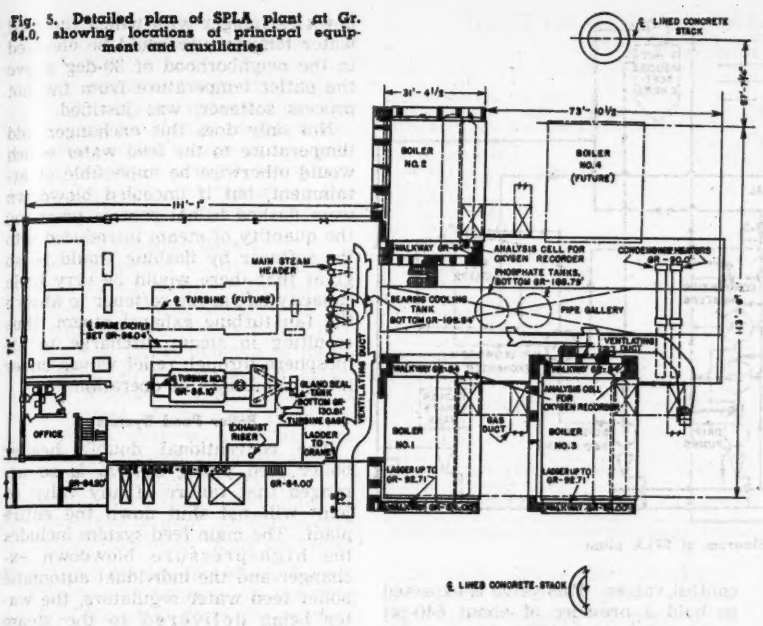


Fig. 4. Detailed plan of SPLA plant at Gr. 68.0, showing locations of principal equipment and auxiliaries

Fig. 5. Detailed plan of SPLA plant at Gr. 84.0, showing locations of principal equipment and auxiliaries



per cent above 3600-rpm are also provided. The turbine has sufficient capacity to develop full kva rating in the generator at unity power factor.

Electrical Connections

The generator is connected to a 13,800-v metal clad withdrawal type switchgear having a double bus and a total of seven 1200-amp oil circuit breakers with an interrupting capacity of 500,000-kva. Three outgoing 13,800-v feeders are connected to the refinery 13,800-v distribution system. The three feeders are led out of the plant underground to getaway pole structures about 150-ft from the power station.

Power at 2300-v for station auxiliaries is supplied by a 2000-kva station service transformer and fed through 2300-v metal clad oil switchgear. An emergency outside source of 2300-v power is also brought to this bus. Power for 440-v auxiliary motor drives is furnished by two 300-kva station service transformers. Details of transformers and switchgear are given in the list of equipment.

Before discussing the station heat balance, some details of the operation of the water treatment and boiler feed systems is desirable, since one of the principal problems in this plant is to prepare almost 100 per cent of suitable make-up water for the boilers to convert into process steam for the refinery.

Water Treating Plant

The SPLA Water Treating Plant is of the two stage type with cold process accelerated clarifying equipment of the Spaulding type in rectangular concrete basins. The clarified water flows through heat exchangers in the power house to hot process deaerating softeners, for further heating, softening, silica removal, deaeration and filtering. Each stage consists of two or more duplicate units to provide for continuous production of fully treated water.

The net capacity is 100,000-gal-per-hr of processed river water at 248-F, not including steam condensed in heating.

Most of the equipment is located outdoors, including bulk storage bins and conveyors for four chemicals. Chemical feeders and control equipment are located in the chemical house along with electrical control and metering equipment, storage space for small lot chemicals and space for a small laboratory.

Premixing of chemicals with influent river water takes place in a 6-ft diameter wood stave standpipe with flume connections to the clarifier basin inlets. Mechanical agitation and remixing takes place in the clarifiers followed by settling and up-flow filtering through the sludge blankets.

The effluent from the clarifiers is pumped through heat exchange equipment in the boiler house, then into the heaters of the hot process sedimentation tanks at temperatures not exceeding 200-F. Chemical solutions are added at the tops of sedimentation tanks and mechanical agitators provide mixing as the water flows downward to the settling portions of the tanks. After settlement, the water passes through internal piping to the deaerator, where it is atomized by the incoming steam as the final step of deaeration, after which it flows to the filters, with sodium sulphite added ahead of the filters. From filters the water enters the boiler feed pump suctions.

The final step of treatment is the addition of phosphate solution in the top drums of the boilers. Rapid diffusion is assured by feeding approximately 2½-gpm to each boiler uniformly distributed over the full length of the feed detention tank in the upper drum.

The usual type dissolving tanks and proportioning pumps handle the sulphite feed. Phosphate solution feed is by high pressure pumps delivering to boilers through feed regulating valves which are mechanically linked to the stems of the boiler feedwater regulators so as to maintain solution flow proportional to feedwater flow to the individual boilers.

Sludge and sand removal is controlled automatically, by timers for the clarifiers and by meters for the hot process tanks. Sludge lines of the clarifiers are kept clear by automatic flushing back with high pressure water after each discharge. Recirculation of sludge in the hot process units will be by means of eductors, each with a centrifugal pump for water supply.

Filter backwash water will be drawn from and returned to the hot process tanks by centrifugal pumps drawing water from the filters. Reserve boiler feed water is stored in a 1,000,000-gal storage tank standing on the boiler feed pump suction line.

A special arrangement is used for diluting phosphate solution and storing it ahead of the boiler feed pumps in two 6000-gal tanks on the boiler room roof. A system of manually opened and electrically trip-closing valves and signal lights permits the operator to fill one of the two tanks three-quarters full of condensate and add concentrated phosphate solution by means of an eductor, which mixes the chemical and water thoroughly, while the other tank, previously prepared, is supplying solution to the feed pumps for feeding to the boilers.

Feedwater Heating System

Feedwater heating is accomplished in five stages as follows:

1. After clarification in the cold process concrete tanks north of the boiler house, water is delivered by the clarified water pumps through two parallel circuits to the low pressure blowdown exchanger. One of these parallel circuits passes through the turbine oil coolers, generator air coders, and condensate cooler in series. The other parallel circuit consists of a by-pass around the first circuit and contains a temperature controlled regulating valve which opens on falling temperature and closes on rising temperature. The control point for this valve is located in the outlet piping from the condensate cooler. The functioning of this valve proportions the water flow between the two circuits to maintain a constant temperature of 100-F at the condensate cooler outlet. This arrangement is necessary as the quantity of makeup water required by the boilers will often be considerably greater than that for which the turbine generator heat exchangers and condensate cooler were designed, making partial by-passing necessary.

2. The second stage is accomplished

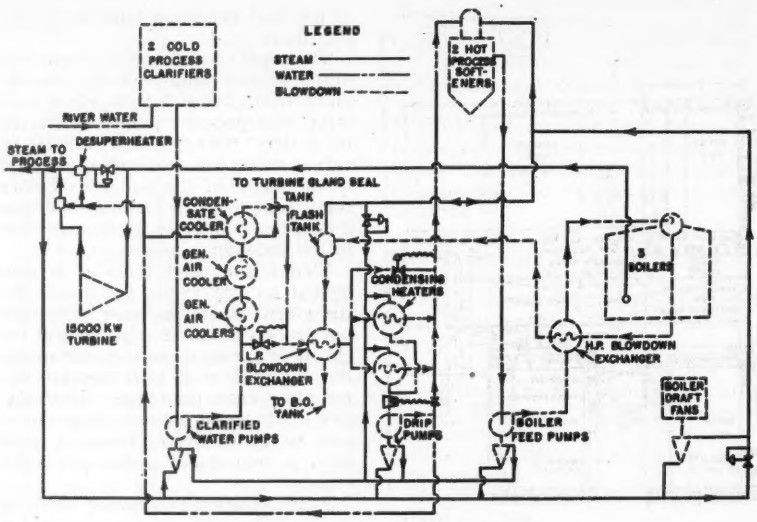


Fig. 6. Basic flow diagram of SPLA plant

in passing through the low pressure blowdown exchanger where the feedwater temperature is increased approximately 29-F.

3. The third stage of heating takes place in the two condensing heaters, which are supplied with exhaust steam from all the turbine auxiliaries except the draft fan turbines. These two heaters are provided with a bypass line containing a temperature-controlled by-pass valve. This bypass valve has its control point located in the water line to the hot process softeners and is so arranged that increasing temperature causes the bypass valve to open. The water temperature to the hot process softeners is limited to 200-F with this arrangement so that a 50-deg temperature rise may be effected in the hot process tanks, thus assuring adequate deaeration

4. The fourth stage of heating (to approximately 250-F) occurs is the hot process tanks, the heat being supplied by the draft fan turbine exhaust steam.

5. The fifth heating stage is carried out at high pressure in the high-pressure blowdown exchanger between the boiler feed pumps and the boilers, a temperature rise of approximately 30-F being effected during feedwater passage through this exchanger.

Blowdown System

Continuous blowdown from each boiler passes through a globe valve to a common header and thence through the high pressure blowdown exchanger. After passing through this exchanger, blowdown pressure is reduced by a pressure control valve and the water is discharged to the flash tank where a pressure of approximately 25-lb is maintained by a control valve on the flash line from the tank to the hot process softener.

The control point for the blowdown pressure control valve is in the common header after the individual boiler control valves. This valve is expected to hold a pressure of about 640-psi gage at this point. With this arrangement, very little adjustment of the globe valves on the lines from the individual boilers with changes of load should be necessary. The flow through the individual boiler flow control (globe) valves will be proportional to the difference between the steam drum pressure and the 640-lb constant pressure in the header after the valves. As steam flow from any boiler increases, boiler drum pressure also increases due to steam pressure drop through the superheater and hence flow through the blowdown flow control valve will increase also.

After a small amount of flashing in the flash tank, the blowdown passes through the low pressure blowdown exchanger to the boiler blow-off tank located in the yard north of the boiler room. Level is maintained in the flash tank by a float operated level control valve regulating the flow from the tank. To prevent shutoff of the tank outlet lines from putting blowdown water into the hot process softeners via the flash line, a high level float is provided controlling a valve in the flash tank dump line to the boiler blow-off tank.

In addition to the continuous blowdown system, an intermittent blowdown connection is provided in the steam drum of each boiler. The funtion of this line is to permit removal of sediment from the bottom of the feedwater detention tank within the steam drum. This line will require only intermittent operation and the quantity blown down will be small.

The character of the water fed to the boilers is such that the percentage of continuous blowdown will necessarily be high, probably in the order of 13 to 15 per cent. With blowdown of this magnitude, considerable heat would be wasted by discharging direct to the blowoff tank. Studies indicated that a high pressure blowdown exchanger with which the feed water temperature could be elevated in the neighborhood of 30-deg above the outlet temperature from the hot process softener, was justified.

Not only does this exchanger add temperature to the feed water which would otherwise be impossible of attainment, but if uncooled blowdown were flashed to hot process pressure, the quantity of steam introduced into the softener by flashing would be so great that there would be very little capacity left in the softener to absorb the fan turbine exhaust steam, thus resulting in steam discharge to atmosphere through relief valves under many conditions of operation.

Boiler Feed System

The conventional double header boiler feed piping system is so arranged that failure of any valve or joint will not shut down the entire plant. The main feed system includes the high-pressure blowdown exchanger and the individual automatic boiler feed water regulators, the water being delivered to the steam drums through the front drum heads.

Each boiler feedwater regulator is of the automatic two-element type operated by a hydraulic cylinder controlled by a pilot valve, which is actuated by the resultant of the effects of variations in both boiler water level and steam flow from the boiler No differential pressure valve is installed ahead of these regulators.

Condensate System

Various services in the power plant require water in relatively small quantities and of a quality better than treated river water. For this reason the installation of condensing heaters for production of condensate was mandatory. Principal uses are as follows:

1. Cooling and sealing of the main turbine glands requires cool condensate to avoid corrosion and deposit difficulties which have been experienced in other plants where cooled treated make-up water had been used.

2. Cool condensate is required for producing phosphate solution for introduction into the boiler drums. Treated river water, if used for this service, would have a tendency to react with the phosphate, causing precipitation in the phosphate feed lines to the boilers with the attendant danger of plugging.

3. Additional cooled condensate is used in the chemical building for sulphite solution preparation.

4. The largest use of condensate is for desuperheating the turbine exhaust and main reducing valve discharge steam. If treated river water were used for desuperheating over extended periods, the solids introduced into the steam by the desuperheaters would be prohibitive and have a very detimental effect in fouling up the surfaces of the various steam users in the refinery and auxiliaries in the power plant. The condensate

supply to the desuperheaters is not cooled as is the case with items 1, 2 and 3 above.

The condensate pump discharge is provided with a recirculating line back to the hot well to maintain suction head on the pumps and a spill-over line to introduce the excess condensate into the clarified water line to the hot process softeners.

Combustion Control

The combustion control system is of the full automatic, metering air-actuated type wherein air and gas fuel supplies are metered and proportioned to steam demand as measured by changes in main steam header pressure. When oil fuel is used, control of the fuel supply is effected manually, with the air supply being regulated automatically by the combustion control system.

An air flow safety controller is also provided to limit the fuel supply to the quantity of air being delivered.

Natural and Refinery Gas Mixing Controls

Natural and refinery gas are supplied to the plant from the refinery area through separate lines and are mixed before being delivered to the gas distribution system serving the boilers.

The refinery gas line is provided with a metering flow control valve with a remote manual control station on the master boiler gage board. The refinery gas flow is manually set at a constant predetermined rate at this control station. The natural gas supply line is provided with a reducing valve to maintain 40 psi in the gas distribution system With this arrangement, variations in fuel demand will result in variations in natural gas flow only.

With this arrangement the composition of the gas mixture fed to the boilers will vary with load, making combustion control fuel-air ratio valve adjustments necessary if station output fluctuations are of large proportions.

Station Auxiliary Drives and Exhaust Steam System

The station is designed to make use of turbine driven auxiliaries to the maximum possible degree, all auxiliary exhaust steam being used for feedwater heating.

In winter time with cold make-up water, no motor drives will be used except in the case of very small station output with all boilers operating, under which condition, due to inefficiency of auxiliary drives at low outputs, the amount of exhaust steam will be excessive in relation to the feedwater to be heated. In such cases, one or more of the motor driven auxiliaries will replace the corresponding turbine driven units to reduce the amount of exhaust steam to be absorbed by the feedwater.

In summer, with the river water make-up at high temperature, the capacity of the make-up to absorb exhaust steam will be much reduced and some motor drives must be used in preference to turbine drives, even at high boiler outputs, to prevent an excess of exhaust steam being discharged to the atmosphere through relief valves.

All steam driven auxiliaries operate on 140-psig, 440-F steam taken from the process steam lines. The fan turbines exhaust at 15-psig to the hot process softeners, while all other seam driven auxiliaries exhaust at 5-psi gage to the condensing heaters. Steam for starting up auxiliaries may be taken from the refinery through the 24-in. process steam lines.

600-lb. Pressure Reducing and Desuperheating System

The system by which boiler steam is reduced from 650-psig 750-F to 140-psig, 440-F consists of four parallel circuits, as follows:

a. Two identical circuits each consisting of one 8-in. pressure reducing valve with a capacity of 500,000-lb-per-hr, followed by a 16-in. venturi type mechanical atomizing desuperheater.

b. One circuit consisting of one 4-in. pressure reducing valve with a capacity of 125,000-lb-per-hr followed by an 8-in. venturi type mechanical atomizing desuperheater.

c. One circuit through the main turbine, which functions as a reducing valve in this case, followed by a steam-atomizing desuperheater in the turbine exhaust line.

The four parallel circuits converge on the low-pressure side through a valve and header system and leave the power plant for the refinery through two 24-in. process steam lines.

The three reducing valves and the four desuperheaters are all supplied with hand-to-automatic control stations, mounted on the process steam control panel, that permit hand control of any element independent of any others.

Automatic control for each reducing valve is through two master controllers in series. The first master controls the valve in normal operation, being actuated by the pressure in the steam line downstream from the desuperheater. The second master is a safety device only, being actuated by the pressure in the steam line ahead of the reducing valve so that it will prevent the reducing valve from passing steam in excess of the ability of the boilers to supply it.

It is expected that when the turbine is operating or when, for any other reason, only a small quantity of steam flows through the reducing valves, the 4-in. valve circuit will be used alone to provide better regulation than a larger valve at low flow. Settings on the back pressure governor of the turbine and on the reducing valves will be made slightly apart so that steam will be permitted to flow through the parallel circuits consecutively.

TABLE I—PERFORMANCE—STEAM GENERATING EQUIPMENT SPLA BOILER AND POWER PLANT BATON ROUGE, LOUISIANA

Fuel	Gas	Gas	Gas	Oil
Quantities—lb per hr				
Steam output at 650 psi gage	125,000	187,500	250,000	250,000
Blowdown (15 per cent)	22,000	33,500	44,000	44,000
Air to air heater	142,300	215,700	290,000	284,100
Air to wind box	126,500	194,000	263,000	257,000
Flue gas to air heater	151,000	226,000	300,000	298,000
Fuel—(C.F.H. gas)	165,900	254,400	345,000	18,060
Temperatures—F				
Air to air heater	80	80	80	80
Air to burners	439	451	460	463
Gas fuel	60	60	60	60
Flue gas to air heater	580	630	675	680
Flue gas from air heater†	299	322	352	350
Steam from unit	700	730	750	730
Feed water to unit	284	283	282	282
Air Pressure Losses				
Through air heater	.80	1.65	2.75	2.65
Air heater to wind box	.12	.28	.50	.50
Through burners	3.60	2.30	4.20	4.00
Total	4.52	4.23	7.45	7.15
Draft Losses				
Furnace	.10	.10	.10	.10
Boiler and S. H.	.46	1.02	1.80	1.78
Ducts to A. H.	.11	.23	.40	.40
Air heater	.75	1.45	2.35	2.30
Total	1.42	2.80	4.65	4.58
Solids in steam leaving boiler	1.0	1.0	1.0	1.0
Excess Air—per cent*	16	13	12	14
Overall Efficiency	82.14	81.74	81.26**	85.52

†Includes leakage *At boiler outlet **Guaranteed

TABLE II—PERFORMANCE—TURBINE GENERATOR EQUIPMENT SPLA BOILER AND POWER-PLANT

Net generator output, kw	18,750	15,000	11,250	7,500	3,750
Fixed losses, kw	180	180	180	180	180
Generator losses, kw	441	464	396	327	313
Power factor, %	100	80	80	80	80
Steam pressure at throttle, psi gage	600	600	600	600	600
Steam temp. at throttle, F	725	725	725	725	725
Enthalpy steam at throttle, Btu per lb.	1,364.7	1,364.7	1,364.7	1,364.7	1,364.7
Heat consumption, Btu per kwhr net	3,525	3,567	3,588	3,642	3,865
Exhaust pressure, psia	155.7	155.7	155.7	155.7	155.7
Degrees of superheat in steam at Exhaust F	100	91	99	115.5	152
Enthalpy of steam at exhaust Btu per lb	1,252.8	1,248.0	1,252.6	1,261.2	1,280.7
Total gland leakage—lb per hour†	2,300	2,300	2,300	2,300	2,300

†Must be piped to vessel having pressure not over 5 psi gage

Principal Equipment in New Baton Rouge SPLA Power Plant
Louisiana Division, Standard Oil Company of New Jersey

GENERAL

Location: Baton Rouge, La.
Type of plant: Industrial steam and power.
Owner: Louisiana Division, Standard Oil Company of New Jersey.
Capacity: 750,000-lb-steam-per-hr, 15000-kw.
Designers and Constructors: Stone & Webster Engineering Corp.

STEAM GENERATING EQUIPMENT

Steam Generating Units: 3—The Babcock & Wilcox Co. integral furnace type boilers. Maximum capacity each, 250,000-lb-per-hr at 650-psig, 750-F at superheater outlet; design pressure 700-psig; heating surface, 20,750-sq-ft including furnace. Furnace walls full stud tubes, partial stud tubes, bare tubes. Boilers, insulation, accessories and air heaters supplied on one order by B & W. Furnace volume, 12,230-cu-ft; heat liberation, 28,300-Btu-per-cu-ft-per-hr.

Superheaters: 3—The Babcock & Wilcox Co. inverted loop type; surface, 2,763-sq-ft each; pressure drop, full load, 19-psi; steam temperature (full load); 750-F with gas firing, 730-F with oil firing; outlet pressure 650-psig.

Air Heaters: 3 — Air Preheater Corp. Ljungstrom regenerative type, 1 per boiler; heating surface 21,800-sq-ft each.

Burners: 18—B & W combination gas and oil (steam atomizing), 6 burners per boiler.

Water Columns: Diamond Power Specialty Co.

Soot blowers: Diamond Power Specialty Co.

Chimneys: Alphons Custodis Chimney Construction Co.

Breechings & Ductwork: Mosher Steel Co.

Forced and Induced Draft Fan Units: 3—Green Fuel Economizer Co. dual units, 1 per boiler, each unit consisting of one SWSI forced draft fan and one DWDI induced draft fan mounted on common shaft between 2 bearings.

Capacity—
F. D. fan 92,000-cfm @ 13.62", 100-F
I. D. fan 155,000-cfm @ 9.45", 375-F

Each dual fan unit driven by Murray Iron Works 755-hp single-stage steam turbine, taking throttle steam 135-psig, back pressure 16-psig, reduction gears to give output shaft speed of 953-rpm.

CONTROLS AND INSTRUMENTS

Combustion Control System: Republic Flow Meters Co. Complete metering type of automatic combustion control for 3 boilers to maintain main steam header pressure by adjustment of air supply, gas fuel supply and furnace draft, co-ordinated by master controller for best combustion. Equipment, mounted on three control panels, one per boiler, includes constant flow controller for refinery gas supply to station and emergency fuel shut-off system to shut off either fuel supply in case of excessive pressure in either of the process steam lines leaving the plant or the turbine exhaust line.

Boiler Feedwater Regulators: 3—Northern Equipment Co. Each regulator includes 1—6" 600-psi Flowmatic regulator valve, 1 Type R thermostat, 1—¾", 600-psi Copes B-1 phosphate feed control linked to reg. valve stem. One 1", 600-psi Copes control valve to maintain differential across phosphate feed control valve proportional to differential across 6" reg. valve.

Multipoint Draft Gages: Bailey Meter Co.

Oxygen Recorders: Leeds & Northrup Co.

Float Controls: Leeds & Northrup Co.

Indicator Controllers: Spence Engineering Co.

Tachometers, Ammeters and Wattmeters for Turbine: Westinghouse Electric Corp.

Pressure Recorders and Float Controls: Bristol Co.

Flow Meters, (steam, gas, water): Bailey Meter Co., recording and integrating.

Temperature Recorders: The Foxboro Co.

Industrial Thermometers: Taylor Instrument Co.

Indicating Pressure Gages: Ashton Valve Co., Star Brass Co., Westinghouse Electric Corp.

Turbine Gage Board: Westinghouse Electric Corp.

Master Boiler Control Board, Process Steam Control Board, Clarified Water Control Board: G & N Engineering Co.

MAIN TURBINE GENERATOR UNIT

Turbine Generator: 1 — Westinghouse Electric Corp.

Turbine: Non-condensing, non-extraction; 2 impulse, 12 reaction wheels. Capacity, 15,000-kw at 80%-pf or 18,750-kw at 100%-pf. Inlet steam conditions: 600-psig, 725-F. Exhaust steam conditions: 140-psig. Speed —3600-rpm.

Generator: 3-phase, 60-cycle, 13,800-v, 3600-rpm, direct-connected, air cooled. Capacity, 15,000-kw at 80%-pf (18,750-kva) Main exciter, 80-kw, 250-v, 320-amp, direct connected. Pilot exciter, 2.5-kw at 250-v, 10-amp, direct connected.

Generator Air Coolers: Tube type; capacity to cool air entering generator to 40-C when supplied with 455-gpm of 90-F river water. Head loss not to exceed 1.5-ft.

Turbine Oil Coolers: Tube type, surface 350-sq-ft, requiring 150-gpm water. ⅝" Admiralty tubes, Muntz metal tube sheets.

Back Pressure Governor: Oil relay type adjustable to maintain back pressure between 135-psig and 155-psig; variation not over 2-psi from 50 to 100% steam flow.

ELECTRICAL EQUIPMENT

13,800-v Switchgear: General Electric Co. double bus switchgear with 7—1200 amp Type FRK-2550 oil circuit breakers. 4 duplex main control panels. 1 neutral oil circuit breaker cubicle with 600-amp type FK-1588 circuit breaker.

2400-v Switchgear: General Electric Co. metal clad single bus switchgear with 6—600-amp type FK-143 oil circuit breakers.

400-v Switchgear: Westinghouse Electric Corp. 460-v metal clad switchgear, drawout type, 2—600-amp type DK-25 air circuit breakers for incoming circuits and 6-100-225-amp type DK-15 air circuit breakers for feeders.

Exciter Air Circuit Breakers: 2—Westinghouse Electric Corp. Type DK-25, 2-pole, in metal cubicle.

Pilot Wire Relays: 3 — Westinghouse Electric Corp. for 13,800-v feeder circuits.

Battery and Lighting Control Switchboard: General Electric Co.

Transformers: 1—Westinghouse Electric Corp. 2000-kva, 13,200/2400-v, 3-phase 60-cycle OISC station service transformer. 2 Moloney Electric Co. 300-kva, 2400/480-v, 3-phase 60-cycle OISC station service transformers. 1 Moloney Electric Co. 100-kva, 2400/240/120-v, 1-phase 60-cycle OISC lighting transformer. 2 General Electric Co. 15-kva, 460/230/115-v, 1-phase, 60-cycle air-cooled station service transformers.

Battery Charging Motor Generator Set: 1 Electric Products Co. 3-kw, 90-140-v.

Spare Exciter: 1—Westinghouse Electric Corp. 75-kw 250-v d-c, driven by 125-hp 2300-v, 3-phase, 60-cycle motor.

Motor Controls, 460-v and 115-v: Westinghouse Electric Corp.

Voltage Regulator, Type BT—30: Westinghouse Electric Corp.

Storage Battery: Philco Corp., 60-cell type 9KFP-21.

Neutral Resistor: 1—General Electric Co., 4-ohm, 2000-amp.

Potheads: Delta Star Electric Co., 15-kv and 7.5-kv compound-filled single conductor potheads.

Wire and Cable: Okonite Co. 600-v and 13,800-v. 400,000-cm to 1750-cm, varnished cambric insulation. Kerite Ins. Wire & Cable Co. 600-v and 2300-v cable No. 6 to 750,000-cm. General Electric Co. 600-v No. 12 to No. 4 wire with Flamenol insulation.

PRESSURE REDUCING & DESUPERHEATING

600-lb Pressure Reducing and Desuperheating System: 1 set—The Swartwout Co. Two 8" by 8" and one 4" by 4", 600-lb carbon moly steel reducing valves; two 16" and one 8", 300-lb cast steel venturi type desuperheaters; master controls, water regulating and differential valves, and load limiting controls to prevent valves from passing steam in excess of available boiler capacity. Thermo master controls, Manual-automatic control panels. One 1¼", 900-lb reducing valve to admit boiler feedwater to desuperheaters if normal supply fails.

Turbine Exhaust Desuperheater: 1—The Swartwout Co. Steam-atomizing type, 6", 300-lb std flange for installation in 20" turbine exhaust line. Atomizing steam valve, water regulating and differential valves, thermo master control, manual-automatic control panel.

Turbine Washing Desuperheater: 1—The Swartwout Co.

Pressure Reducing Valves: Fisher Governor Co.; 140-psi to 15-psi system; 15-psi to 5-psi system.

PUMPS AND HEATERS

Boiler Feed Pumps: 3—Byron Jackson Co. 4-stage horizontal centrifugal pumps. Capacity each, 678,000-lb-per-hr at 1840-ft head; 3600 rpm. Two pumps each driven by Elliott Co., 880-hp single stage steam turbine, throttle steam 135-psig 440-F, back pressure 6-psig, at 3600-rpm. One pump driven by GE 900-hp, 2300-v, 3-phase, 60-cycle, 3600-rpm induction motor.

Clarified Water Pumps: 3—Union Steam Pump Co. 1-stage horizontal centrifugal pumps. Total capacity 1145-gpm; discharge head 253-ft, speed 3600-hpm. Two driven by Elliott Co. 105-hp single stage turbine, throttle steam 135-psig, 440-F, backpressure 6-psig at 3550-rpm. One pump driven by GE Co. 100-hp, 2300-v, 3-phase, 60-cycle, 3550-rpm induction motor.

Heater Drip Pumps: 2—Byron Jackson Co. 4-stage horizontal centrifugal pumps. Total capacity 200-gpm, discharge head 350-psig, speed 3550-rpm. One pump driven by Elliott Co. 105-hp single stage turbine, throttle steam 135-psig, back pressure 6-psig at 3550-rpm. One pump driven by Byron Jackson Co. 75-hp, 440-v, 60-cycle, 3-phase, 3550-rpm induction motor.

High-Pressure Blowdown Exchanger: 1—Lummus Co. horizontal floating head type. Surface 1535-sq-ft; shell, 33¼" ID, 1⅜" thick; 900-psi design pressure; tubes 1" — 12 ga steel 16' long, 725-psi, design pressure, 8 pass.

Low-Pressure Blowdown Exchanger: 1—Whitlock Mfg. Co. horizontal floating head type. Surface 1400-sq-ft, shell 27⅜" ID, 5/16" thick; tubes ¾" 16 ga Admiralty, 16' long 8 pass. 100-psi design pressure.

Condensing Heaters: 2 — Lummus Co., horizontal floating head type. Surface 2060-sq-ft each. Tubes ¾" 18 ga. Admiralty 16' long, 4 pass 100-psi design pressure. Shell 31¼ ID, ⅜" thick, 1 pass, 50-psi design pressure.

Condensate Cooler: 1—Whitlock Mfg. Co. horizontal floating head type. Surface 188-sq-ft. Tube 1" 17 ga Admiralty 81' long 2 pass, 250-psi design pressure. Shell 17¼" ID, ⅜" thick, 1 pass, 400-psi design pressure.

Fuel Oil Storage Tank Heaters: 2—Whitlock Mfg. Co. horizontal U-bend type. Surface 695-sq-ft. Tubes 110 U-bends of 1.05" OD x 0.113" steel, 150-psi design pressure. Shell 24" OD, 5/16" thick, 14' long, open end.

Fuel Oil Pump Discharge Heaters: 2—Whitlock Mfg. Co. horizontal fixed tube type. Surface 250-sq-ft each. Tubes ⅝" 16 ga steel 10" long, 250-psi. Shell 14" OD, ⅜" thick 12' long, 150-psi.

Fuel Oil Pumps: 2—DeLaval Steam Turbine Co. Type A-32P screw pumps. Capacity 100-gpm each at 250-psi discharge pressure operating with Bunker C fuel at 175-SAF at 1150-rpm. Each pump driven by L. J. Wing No. 5 single stage turbine, throttle steam 140-psig, 6-psig back pressure.

PIPING, VALVES AND ACCESSORIES

Piping: Midwest Piping & Supply Co.; all piping 3" and larger nominal pipe size, except piping around filters and between filters and hot process softeners which was furnished by Cochrane Corp. Piping around main turbine, Westinghouse Electric Corp. Miscellaneous clarifier piping, Permutit Co.

Copper Expansion Joints: Joseph Kopperman & Sons Co.; 4" to 24".

Low-pressure Bronze Globe and Check Valves: Ohio Injector Co., ⅜" to 2".

High-pressure Forged Steel Valves: Edward Valve Mfg. Co.; ⅛ to 2" for 650-psi 750-F steam, 700-psi 500-F blowdown, 800-psi, 300-F feedwater service.

Principal Equipment in New Baton Rouge SPLA Power Plant —Continued

900-lb, 600-lb, 300-lb, 125-lb. Iron & Steel Valves, for various plant services in sizes from 24" down to 2" by various manufacturers, such as: The Wm. Powell Co.; Northern Equipment Co.; Edward Valve Mfg. Co.; The Swartwout Co.; Crosby Steam Gage & Valve Co.; Ohio Injector Co.; Fisher Governor Co.; Ruggles-Klingemann Mfg. Co.; Ashton Valve Co.; Powers Regulator Co.; Automatic Temperature Control Co.; Combination Pump Valve Co.; Atwood & Morrill Co.; Cochrane Corp.; Merco-Nordstrom Co.; Spence Engineering Co., Inc.

OTHER AUXILIARIES AND ACCESSORIES

Trench Drain Pump: 1—Yeomans Bros. Co. vertical single stage centrifugal 3500-gph at TDH of 30-ft driven by ½-hp 110-v weatherproof motor.

Station Crane: 1—Harnischfeger Corp. four-motor, 40-ton traveling crane for 62'—11½" span; 5-ton auxiliary hoist.

Steam Traps: Armstrong Machine Works.

Fuel Oil Strainers: Elliott Co.

Turbine Oil Filtering System: S. F. Bowser Co.

WATER TREATMENT PLANT

Precipitators: 2—The Permutit Co., for clarification of water. Concrete and steel; each 26' 10" wide by 47' long by 13' deep. Capacity each, 895-gpm; detention time 112-min; upflow rate 0.75-gpm-per-sq-ft.

At designed capacity, precipitators are built to deliver effluent having turbidity not exceeding 10-ppm when influent turbidity does not exceed 2500-ppm. With influent turbidity between 2500 and 5000-ppm, effluent turbidity not to exceed 2½% of influent turbidity.

Various components of the equipment, as fabricated by various manufacturers and supplied in the precipitator assembly by The Permutit Co. as follows:

Concrete Tanks, steel partition walls, flumes, paddle agitators, driving motors and controls; flush back, sludge blow-off, sand removal headers; time switches, strainers, gate valves, solenoid and diaphragm valves, stuffing boxes, fastenings, provided by The Permutit Co.

Mixing Tank: 1—The Permutit Co., 6' diam. by 13' high wood stave construction, for mixing diluted solution ferric sulphate and lime with influent water.

Basin Level Regulator: 1—The Permutit Co.

Meters: Builders-Providence, Inc.: 1—Chronoflo 16" indicating recording and totalizing, with 16" venturi tube, with proportioning sender. 2—Chronoflo 8" indicating, recording and totalizing, with 8" stainless steel orifices and proportioning senders.

Feeders: Omega Machine Co., 2— gravimetric lime feeders with stakers; 2 ferric sulphate feeders; 3 rotary lock soda ash feeders; 2 rotary look dolomitic lime feeders.

Conveyor System: Stephens-Adamson Mfg. Co., for handling dry chemcials from railroad cars to storage bins and transferring chemicals from bins to feeder hoppers. 2 horizontal Redler conveyors; 1 vertical continuous type bucket elevator; 1 power shovel for box car unloading, 4 Redler reclaiming conveyors; all motor driven.

Chemical Storage Bins: 4—The Ingalls Iron Works Co., steel with structural steel supports.

Electric Eye Controllers; Turbidity Detectors; Densometer: 2—Photoswitch, Inc.

Phosphate Dissolving Tank: 1—The Permutit Co., Steel.

Phosphate Solution Recirculating Pumps: 2—Ingersoll-Rand Co.

Phosphate Transfer Eductors: 2—Schutte & Koerting Co.

Phosphate Feed Pumps: 2—The Deming Co., 10-gpm each at 900-psi discharge pressure; 7½-hp, 440-v a-c motor drive.

Sulphite Dissolving Tanks: 2—The Permutit Co.

Sulphite Solution Recirculating Pumps: 2—Ingersoll Rand Co., 140-gpm each.

Sulphite Feed Pumps: 3—Proportioneers, Inc. 24-gph each at 50-psi discharge pressure, motor driven, designed for future automatic proportioning features.

Hot Process Water Softeners: 2—Cochrane Corp.; capacity 50,000-gph of clarified Mississippi River water; one hour detention time. Tanks 21'6" in diameter by 24-ft high straight side section; designed for 15-psi. Each tank has jet heaters, internal uptake funnel, clear water compartment, raw water regulating valve and float box, 5 vacuum breakers, stirring mechanism, sludge eductor, vent condenser, deaerating atomizer and necessary pumps, piping, valves, gage glasses and other accessories.

Softener Pressure Filters: 9—Cochrane Corp., welded steel plate construction 10' diameter by 6' high over straight side section; designed for 50-psi.

Water Softening Equipment to have continuous net output of 50,000-gph for each unit. Water retention, 400,000-lb each tank; deaerated water storage, 66,700-lb.

Hardness in effluent of softener filters, using indicated excesses of sodium carbonate and caustic soda as determined by APHA test, to be as follows:

Excess Alkalinity in terms of Sodium Carbonate	Hardness in Terms of Calcium Carbonate
20-ppm	18-ppm
30-ppm	13-ppm
40-ppm	9-ppm
50-ppm	7-ppm

Designed to reduce oxygen content of effluent water to zero; to reduce silica to 3-ppm or less using magnesium oxide or dolomitic lime. To produce this result; requires up to 75-lb soda ash, 30-lb magnesium oxide, 50-lb lime or dolomitic lime per million pound effluent water.

Backwash Pumps: 2—Ingersoll Rand Co., capacity each 1000-gpm, 70-ft total dynamic head, driven by 25-hp 440-v GE splashproof motor. Pumps for returning filter backwash effluent to hot process softeners at 250-F max.

Valves: 2—National Lead Co. 1½" hard lead Y pattern flanged valves with rubber plug discs for ferric sulphate lines. 75 Lunkenheimer Co. globe valves and check valves for soda ash, dolomitic, lime, sulphate and phosphate lines. 6—1½" Fairbanks Co. valves for chemical solution lines.

Water Flow Indicator: 1—Cochrane Corp., including 1 monel orifice and fittings, 1 Hays modified Jumbo type wall-mounted mercury manometer for flow from 0 to 75,000-lb-per-hr, 125-psi, installed in continuous blowdown water supply from boiler plant to soda ash and dolomitic feeders and to hot process softeners.

Diaphragm Motor Valves: 4—Fisher Governor Co., for 1000-psi, 450-F. Two ½" for 900-gpm of condensate each. Two 1¼" for 2400-gpm of condensate each. Also 8⅜" needle valves and 2⅜" strainers.

Solenoid 3-way Valves: Automatic Switch Co.

Control Valves: 4 Copes — Northern Equipment Co., 600-lb for control of phosphate to boiler drums in proportion to feedwater flow.

Tellurium Lead Pipe: 400-ft, National Lead Co., for ferric sulphate line.

Piping, Valves and Fittings not supplied as above: Ohio Injector Co., Midwest Piping & Supply Co.

Surge Tank (second hand): 1—Standard Oil Co. of N. J., 30-ft diam. by 12' 4½", steel.

Wood Tanks: 2—Lincoln Tank Co. 10' diam. x 10' high.

Storage Tank: 1—Material Acquisition Engineering Co., 25,000-bbl, welded steel 70' diam. x 36'6" high.

Sump Pump: 1—Yeomans Bros. Co., capacity 24-gpm, 20' TDH, 1150-rpm, driven by ½-hp 110-v motor pump installed in drainage sump of bucket elevator.

Safety Precautions

All equipment except turbine exhaust casing, process steam lines and auxiliary turbine drive casings is provided with safety or relief valves or other devices of adequate relieving capacity. Auxiliary drive turbine exhaust casings are provided with sentinel relief valves in the usual manner.

Protection of process steam lines and main turbine exhaust casing with safety valves alone, however, would require a large number of steel valves, expensive and difficult to obtain in wartime. Accordingly, these lines are protected by the following method:

First, each of the three reducing valve discharge lines leading to the 24-in. process lines, and the turbine exhaust line is equipped with two 6-in. safety valves to relieve a portion of the total overpressure and relieve momentary overpressures due to operating swings. In the case of the smaller reducing valve line, these two safety valves will afford complete protection. The other two larger reducing valve discharge lines and the turbine exhaust line are protected by two additional features.

First, in each line is installed a system of pressure switches, each set higher than the safety valve setting and connected to close six quick-acting motor-operated valves in the boiler fuel supply lines, thus preventing further generation of steam. These motor-operated valves are opened by manual operation of push-button stations at the valves.

Second, two safety diaphragms are installed in each line, designed to rupture at 210-psig, in case the motor-operated valves fail to work in an emergency.

Bearing Cooling System

Because of the limited supply of well water available for service water at the site, clarified river water from the clarified water pump discharge is used for bearing cooling. Because this clarified water is too valuable to waste, a closed cooling system is used. In this system, a double header arrangement assures continuity of service.

Acknowledgments

For the most cordial co-operation in making available the data on the SPLA plant given above, we are indebted to the Louisiana Division, Standard Oil Company of New Jersey and to Stone & Webster Engineering Corp. Technical data were furnished through the co-operation of W. F. Ryan, assistant engineering manager of the Stone & Webster organization. T. A. Fearnside was the Stone & Webster engineer in charge of the design of the SPLA power plant.

(To be continued. Part II, in a subsequent issue, will discuss the heat balance).

New Atmospheric Relief Valve for Condensing Turbo-Generators

Development of valve with lead disc which is mechanically sheared to relieve pressure . . . Swinging gates shear disc and give free passage to exhaust steam . . . With no valve stem, nor moving parts, nor access platform, the valve is compact . . . Disc protected from corrosion by acid-proof, non-oxidizing grease . . . Details of valve construction and operation

By **M. C. RANDALL** Senior Engineer, Mechanical Division, Philadelphia Electric Company

THE ATMOSPHERIC RELIEF VALVE is one of the most important adjuncts of the modern condenser, yet under load, the most infrequently operated piece of apparatus in the power plant. This valve is the ever present sentry, guarding against turbine exhaust end damage should the unit go over to high pressure. This condition might result from failure of condenser circulating water, seals, condensate pumps or several other causes.

Power plant designers are familiar with a number of atmospheric relief valves, the most common of which is the water loaded or sealed type. This latter, by the very nature of its function, is a large and cumbersome piece of equipment, requiring extremely valuable space which the designer can ill afford to allocate to it.

The ever growing trend toward the more efficient utilization of space in modern power plant design has been the incentive for a new and radical departure in atmospheric relief valve construction, which has accomplished a material conservation of space, yet embodies all the requisite features necessary to adequate exhaust protection.

Distinctive Features of New Valve

Probably the most outstanding feature of this new valve is the novel employment of a very thin lead disc or diaphragm, which upon a reversal of pressure is mechanically sheared by means of swinging gates. This shearing is accomplished well below the allowable turbine exhaust end pressure. The steam passage through the valve is such that it is equivalent in cross sectional area to that of the exhaust piping between the condenser and the exhaust stack. The actual pressure drop through the valve is no greater than that of the exhaust piping itself.

A corrolary of this light, compact design is the elimination of the traditional practice of annual operation of the valve because of accumulated corrosion. This is accomplished by the use of a special acid-resistant, non-oxidizing grease which permanently protects the diaphragm and working parts, assuring operation at any time. In addition there are no external moving parts, nor is an access platform required.

During the early stages of development, various metals and materials were tried as purely rupture discs supported against vacuum by a fixed grid. It was found that the diaphragm could be supported but that uniform rupture valves could not be obtained. It was therefore decided to utilize a positive mechanical means of rupturing the diaphragm.

Several methods were tried, but none were successful until pivoted swing gates were developed. The periphery of the gates, on the diaphragm side, were provided with a sharpened edge so that upon a reversal of pressure the gates actually sheared the diaphragm. The next problem to be solved was to keep the sheared diaphragm from being carried into the exhaust piping and creating a stoppage in the line, thereby defeating the purpose of the valve. This potential danger was eliminated by installing cover plates on the gates which fixed the diaphragm solidly in place. This latter improvement served a dual purpose; it eliminated line stoppage, and provided adequate support for the thin lead sheet which otherwise would have failed due to its own weight.

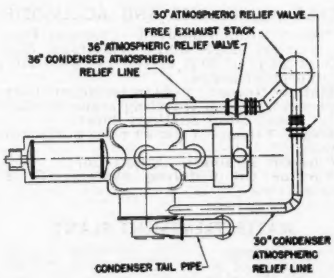

30" ATMOSPHERIC RELIEF VALVE
FREE EXHAUST STACK
36" ATMOSPHERIC RELIEF VALVE
36" CONDENSER ATMOSPHERIC RELIEF LINE
30" CONDENSER ATMOSPHERIC RELIEF LINE
CONDENSER TAIL PIPE

Fig. 2. Plan view of typical atmospheric relief valve installation for a large turbo generator unit that would require relieving capacity of 1,000,000 lb of steam per hour

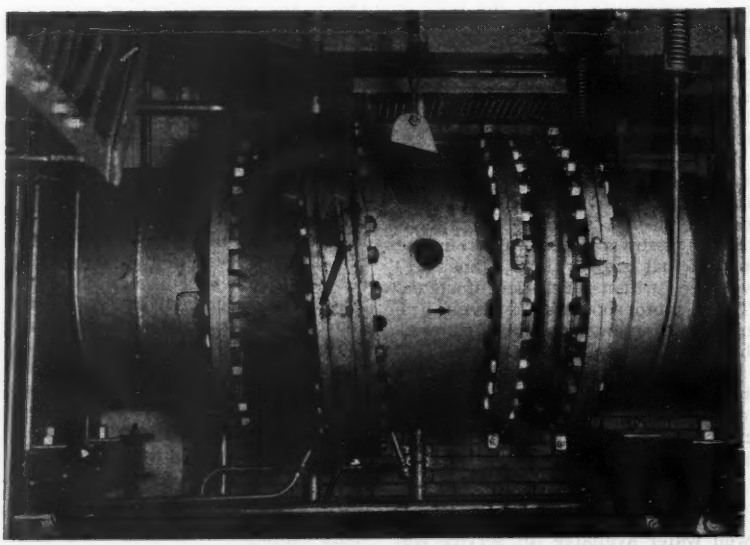


Fig. 1. A 36-in. atmospheric relief valve installed in the condenser atmospheric relief line at the Chester Generating Plant of the Philadelphia Electric Co. This view indicates the method of supporting a valve of this type together with the provision for line expansion. The pins appended to the gate ring are used for locking the gates in place when the gate ring is removed from the line. The plugged nipple is used for inspection of the diaphragm. The arrow indicates the direction of steam flow in case the valve is called upon to operate

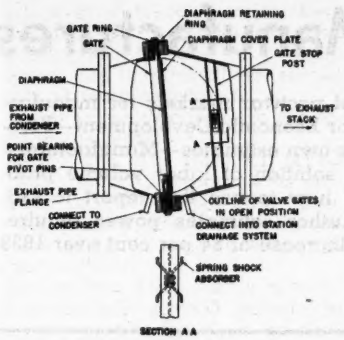


Fig. 3. Cut away view of the relief valve indicating the position of the gates supporting the diaphragm

After the valve had been placed in operation another difficuly arose. As the result of a very dilute acid (created by stack condensation, coal dust and fly ash) the diaphragm was attacked to such an extent that failure occurred within a few weeks. To overcome this, various resin inhibitors were tried without complete success until an acid-proof, non-oxidizing grease was applied to both surfaces of the lead. This application has been thoroughly tested now on an 80,000-kw unit installed in 1942 at the Philadelphia Electric Co.'s Chester Station. The same design will be used on the 150,000-kw unit in their new Southwark Plant where the same satisfactory performance is expected. Frequent inspection has shown no discernible deterioration in over a year and half's continuous service.

Details of Valve Construction

The new atmospheric relief valve consists of two annular rings, one carrying two semi-circular, pivoted gates, and gate seats which form the supporting medium for the diaphragm, and a second annular ring of slightly greater internal diameter serving as the clamping ring for the diaphragm. These two elements when assembled with the gates on the vacuum side of the diaphragm, form the sealing agency between the exhaust system and the condenser. The ring and disphragm assembly is interposed between the large flanged ends of two conic sections or frustums; thus an arrangement is obtained whereby the effective flow area of the exhaust pipe is substantially constant.

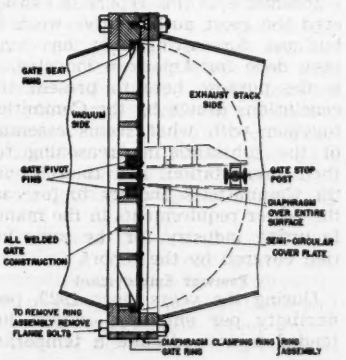


Fig. 4. Cross section of the rising assembly with the gates in the closed position. The dotted line indicates the gates in the open position with the diaphragm sheared, permitting free passage of the steam to the exhaust stack

Each of the conic sections is provided with a small drain or drip line. The line from conic section under vacuum is run to the condenser, the other line on the atmospheric side may be connected to the station drainage system. The purpose of these small lines is to lead off any condensate which would otherwise collect at the low points of the two conic sections.

Figure 3 shows a sectional elevation of the valve. It will be noted that the ring assembly is set at a slight angle, 5 deg from the vertical to be exact. The purpose of this inclination is to obviate any stress being imposed upon the diaphragm by the gates. The inclined post in the atmospheric conic section serves as a stop in order that the gates may not travel beyond center. Flanged ends are shown in Fig. 3 for installation in the free exhaust line. The valve may be welded in the line if necessary, thereby eliminating one possible source of leakage.

Fig. 4 shows the method of operation and the various component parts composing the ring assembly.

Fig. 5 gives a frontal view of the atmospheric side of the diaphragm and the two semi-circular swing gates.

Valve Operation

Once the valve has been called upon to operate, replacement of the diaphragm is relatively simple. The gate locking pins are inserted through threaded holes provided in the gate section of the ring, the flange bolts are removed and the ring assembly is lowered to the floor where the diaphragm retaining ring, the gate cover plates and finally the ruptured diaphragm is removed.

In preparation for placing the new diaphragm, the gates and gate ring are coated with a heavy viscous grease, the new diaphragm is then placed over the gates and in turn is coated with the same heavy grease. The gate cover plates and the diaphragm retaining ring may now be bolted in place, with this accomplished, the ring assembly is ready for reinstallation in the line.

After the ring is bolted up, the locking pins are removed, the seal plugs replaced and the valve is again ready for operation. The locking pins are hollow drilled and it is impossible to develop vacuum until they are removed.

This valve can be built in any size to relieve from 10,000 to 550,000 lb of steam per hour. For steam quantities in excess of 550,000 lb per hour, the usual practice is to use two valves

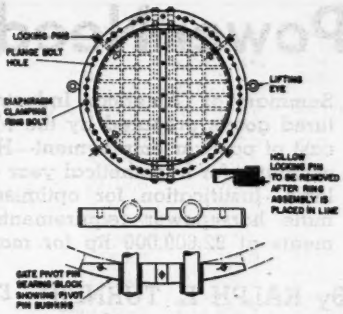

LOCKING PINS
FLANGE BOLT HOLE
LIFTING EYE
DIAPHRAGM CLAMPING RING BOLT
HOLLOW LOCKING PIN TO BE REMOVED AFTER RING ASSEMBLY IS PLACED IN LINE
GATE PIVOT PIN BEARING BLOCK SHOWING PIVOT PIN BUSHING

Fig. 5. Frontal view from the atmospheric side of the valve of the ring assembly and details of the method of locking gates in position while handling the ring assembly

whose total cross sectional area is equal to the total relief area provided by the condenser manufacturer. For example, it would require a 30 in. and a 36 in. valve to relieve 1,100,000 lb of steam per hour assuming an initial throttle admission pressure of 250 lb gage at 600F total temperature.

Some of the outstanding advantages of an atmospheric valve of the new design are: simplicity of construction; elimination of water seal with necessary continuous water supply; compactness, there being no stem, packing gland or hand wheel, all of which require space and an access structure; fully developed cross sectional area of the exhaust pipe; easy access for inspection; complete and assured pressure release when called upon to operate.

Due to the all welded construction of this type of valve, the cost is considerably lower than that of the standard relief valve.

Aluminum Substitute for Steel and Plywood

Because of critical shortages of steel and plywood, Army Engineers are substituting aluminum sheet in the construction of prefabricated hospitals, barracks and warehouses for use overseas. This substitution is made possible through the cooperation of Headquarters, Army Service Forces, and the War Production Board.

The building programs of the Corps of Engineers are varied, in that the Engineers are charged with the production of all types of buildings required by the Army. Plans at the present time call for the production, during the last half of 1945, of 53,970 buildings in all of which aluminum will be substituted for steel or plywood. The original order was for 10,610 steel insulated barracks; 6,920 steel extension units; 9,096 plywood barracks; 11,329 plywood extension units; 11,887 shell tropical-type barracks; 4,028 insulation kits to convert the tropical steel barracks to temperate type; and 100 warehouses.

Power Needs for Postwar Manufactures

Summary of "American Industry Looks Ahead," a business estimate of postwar markets for manufactured goods prepared by the Marketing Committee of the Committee for Economic Development—Forecast of postwar employment—How American manufacturers made their own estimates—Manufacturers' estimates for hypothetical year of 1947†—Estimates designed to aid in solution of labor volume problems—Justification for optimism for 1947 explained—Explanation of how to use this report to estimate horsepower requirements of manufacturing establishments—Author estimates power requirements at 92,600,000 hp for manufacturing establishments in 1947, an increase of 84 per cent over 1939

By **RALPH E. TURNER*** *Editor, Power Plant Engineering*

AFTER MANY months of intensive work in gathering, compiling and analyzing statistics dealing with the various phases of the manufacturing industry of the United States, the Marketing Committee of the Committee for Economic Development released on August 20 a report entitled "American Industry Looks Ahead" which, in reality, is a business estimate of postwar markets for manufactured goods. This committee, under the chairmanship of T. G. MacGowan, manager, market research department of the Firestone Tire & Rubber Co., consists of 55 carefully chosen market research specialists, economists and statisticians all of whom have worked diligently on this immense project to present authoritative data that can be relied upon as background upon which to plan postwar activities.

Prepared, as this report was, to foreshadow, so far as possible, the size of the market for manufactured goods in the first full postwar year after reconversion to peace-time economy, the Committee presents much of its findings in tabular form supplemented by rather exhaustive reasons for its conclusions thus placing in the reader's hands data from which to draw his own conclusions regarding the applicability to his own field of estimates made by the Committee.

More than 1500 manufacturers and manufacturers' trade associations have made forecasts of postwar markets in their various industries, and these have been combined into one forecast for all manufacturing industry. On the basis of this forecast and other data, the Committee has developed indications for this same early postwar year, designated for convenience as 1947, of: 1. The probable level of manufacturing employment. 2. The level of employment in the economy as a whole which might go along with such a level of activity in manufactures.

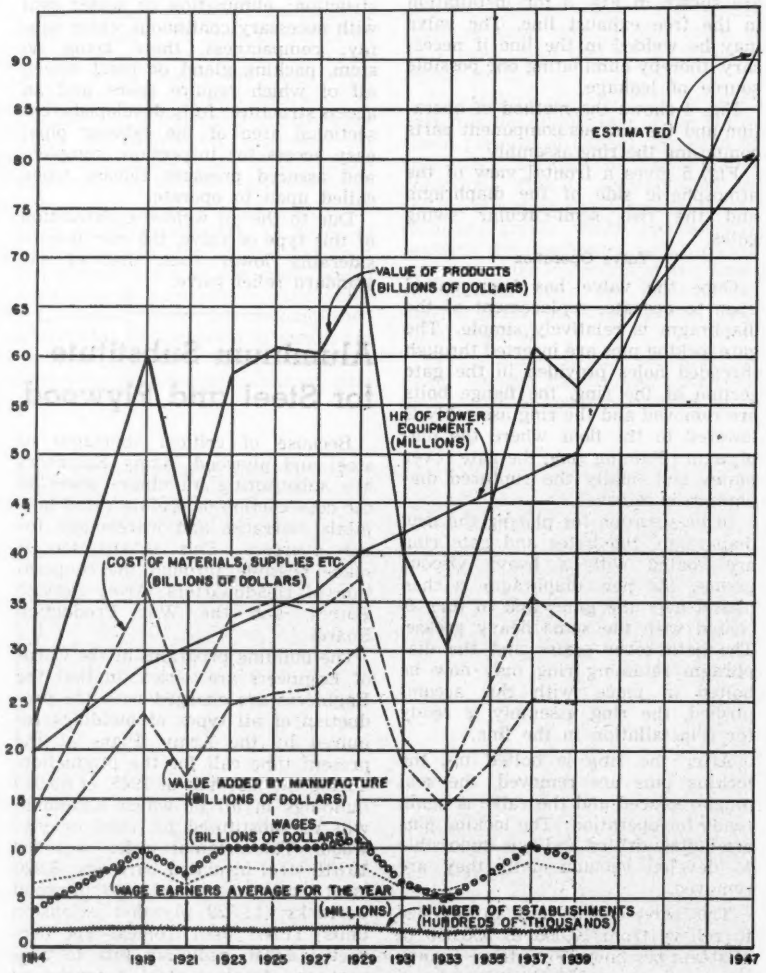


Fig. 1. Summary of manufacturing industries

Table I. Estimates of the Number of Needed Civilian Jobs, 1947
(In Millions)

	From	To	Best Guess
Total Labor Force	58.2	62.0	60.1
Armed Forces	4.0	2.0	3.5
Civilian Labor Force	54.2	60.0	56.5
Permissible "Labor Float"	4.0	1.5	2.5
Needed Civilian Jobs	50.2	58.5	54.0

Inasmuch as this report is considered the most authoritative work in business forecasting that has ever been done for American industry, it is the purpose here to present the conclusions drawn by the Committee together with what seems essential of the substantiating reasoning for their presentation, and then to use the Committee's findings to forecast the power requirements in the manufacturing industry for the same period covered by the report.

Postwar Employment

During the years since 1929, productivity per employed person has tended to rise, despite a temporary

†Peace having now been attained, the forecasts will be reached about September, 1946, instead of 1947 as indicated in the report and throughout this article.

*Member Business Publication Committee of Committee for Economic Development.

decline during the early thirties. In wartime great scientific strides have been made, and many of these will ultimately be reflected in a sharp postwar rise in productivity, particularly in manufacturing.

Three postwar periods are considered in the report:

Period One. The transition period in which industry reconverts its productive facilities to peacetime uses. In this phase a large part of the job of unwinding the war economy will be accomplished.

Period Two. The catching-up-with-the-accumulated-demand period. In the early part of this stage we shall still have an abnormally large number of persons in the armed forces. During the whole of this period sales will be stimulated both by demand for goods unobtainable or scarce during the war, and by the presence of the very large savings.

Period Three. The period in which we attempt to shift successfully to a self-sustaining basis. Jobs will depend upon current demand and current income. The full effects of the increase in the labor force and the wartime increase in productivity will now be felt.

The Committee points out that the first period is one in which good planning and speedy and orderly execution of plans by both government and business can bear sound fruits in miming transitional unemployment.

It is the view of many economists that the third period is basically the one fraught with the greatest danger to our economy and its institutions.

But the second period is of more immediate moment, because its dangers and problems are nearer at hand. It is important not only for its own sake but because it is essential that during this period we prepare to cope with the problems of the period to follow.

In this study, the Committee endeavors to shed light on the probable level of activity in the whole economy, in one year, through detailed analysis of one very important and influential segment of it—manufactures.

The second postwar period — the catching - up - with - accumulated - demand period — is one selected for analysis. The year which has been selected within that period is the first full postwar year after a substantial element of industrial reconversion shall have taken place. The year which has been arbitrarily defined in that way for the purposes of the study is 1947.

To answer the question "What is the 1947 employment goal?" the Committee started with a demonstration of how many persons there will be in that year in the "labor force," or body of persons working or seeking work.

In 1929 the labor force included 48,060,000 persons. By 1939 this number had been expanded to 54,106,000, an average annual expansion of about 600,000. Yet in 1944, under the impetus of war, the labor force numbered 64,010,000. In the three-year period from 1941 to 1944 it had expanded by more than 8,000,000 persons.

Opinions of a number of authorities as to the size of the labor force in 1947 vary between 58,200,000 and 62,000,000. The range of responsible view on the permissible civilian "labor float" is perhaps from a low figure of 1,500,000 to a high of 4,000,000.

All factors considered, the Committee arrived at the figures shown in Table I as the most reliable assumptions.

Summarized, the 1947 civilian employment goal may be vizualized as a 20.3 per cent increase over 1939.

Table II. Value of Manufactures by Principal Groups 1939 and 1947

No.[1]	INDUSTRY	Value of Manufactures (Millions of Dollars) 1939	Estimated 1947	% Increase Est. 1947 Over 1939
		(At 1939 Price Level)		
	NON-DURABLE GOODS			
1.	Food and kindred products	$10,618.0	$14,185.6	33.6%
2.	Tobacco products	1,322.2	2,240.0	69.4
3.	Textile and fiber products	3,930.7	4,997.9	27.2
4.	Apparel and other fabric products	3,325.0	4,136.3	24.4
7.	Paper and allied products	2,019.6	2,579.3	27.7
8.	Printing, publishing and allied industries	2,578.5	3,359.8	30.3
9.	Chemicals and allied products	3,733.7	5,907.3	58.2
10.	Petroleum and coal products	2,954.0	4,023.5	36.2
11.	Rubber products	902.3	1,329.2	47.3
12.	Leather and leather products	1,389.5	1,699.3	22.3
	TOTAL NON-DURABLE	$32,773.3	$44,458.2	35.7%
	DURABLE GOODS			
5.	Lumber and timber basic products	$ 1,122.1	$ 1,412.8	25.9%
6.	Furniture and finished lumber products	1,267.7	1,872.5	47.7
13.	Stone, clay and glass products	1,440.2	2,062.6	43.2
14.	Iron and steel and their products, except machinery	6,591.5	9,052.4	37.3
15.	Nonferrous metals and their products	2,572.9	3,710.1	44.2
16.	Electrical machinery	1,727.4	2,698.3	56.2
17.	Machinery, except electrical	3,254.2	4,961.1	52.5
18.	Automobiles and automobile equipment	4,047.9	7,117.6	75.8
19.	Transportation equipment, except automobiles	882.9	1,539.1	74.3
	TOTAL DURABLE	$22,906.7	$34,426.5	50.3%
20.	MISCELLANEOUS INDUSTRIES	$ 1,163.0	$ 1,630.3	40.2%
	GRAND TOTAL (All manufacturing industry)	$56,843.0	$80,515.0	41.6%

[1]These are the numbers by which these 20 manufacturing groups were designated in the 1939 U. S. Census of Manufactures.

Manufacturers Made Own Estimates

The Committee felt that the people best qualified to do the estimating jobs were those most familiar with the situations and problems involved —the manufacturers themselves. It was felt that while a great deal of help could be obtained from the trade associations of manufacturers, the main reliance should be on the manufacturers.

It was desired to obtain estimates in as many as possible of the more than 400 main subdivisions into which the 20 chief classifications of the 1939 Census of Manufacturers was divided. The Committee was especially interested in some 210 subclassifications which in 1939 accounted for more than 85 per cent of the total value of American manufactures.

The manufacturers were not making estimates of their individual companies, but were asked to do exactly what the trade associations who cooperated were to do: that is, produce forecasts for their industries.

These forecasts were to represent the amount of business the estimators thought would actually materialize in their respective industries.

The only assumption which was necessarily to be common to all estimates was the very arbitrary one that 1947 be the first full postwar year and that by that year a very substantial element of the industrial reconversion would have been completed.

Beyond that, the estimators could make any assumptions they chose regarding the so-called "environmental" factors which would depend upon planning or action by Government or business, upon the level of consumer confidence, or upon affairs outside of the United States.

The forecasting method employed called essentially for: (1) charting the percentage relationship between a given industry and the gross national product over the years, (2) forecasting the gross national product for 1947 on the basis of the number of employed and their productivity, (3) forecasting the 1947 percentage relationship between the industry in question and the gross national product in that year, and (4) applying this percentage to the forecast of the 1947 gross national product.

In summary the Committee's view of the estimates is substantially this:

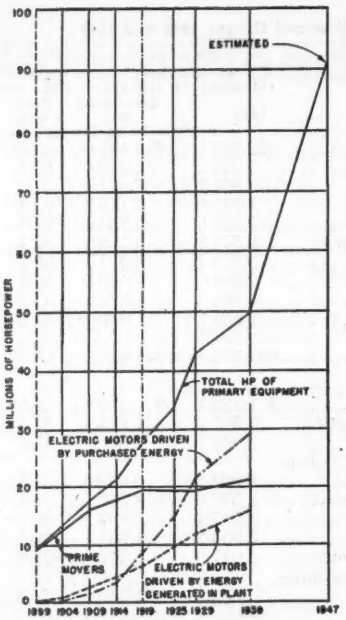

ESTIMATED
TOTAL HP OF PRIMARY EQUIPMENT
ELECTRIC MOTORS DRIVEN BY PURCHASED ENERGY
PRIME MOVERS
ELECTRIC MOTORS DRIVEN BY ENERGY GENERATED IN PLANT
MILLIONS OF HORSEPOWER
1899 1904 1909 1914 1919 1925 1929 1939 1947

Fig. 2. Installed capacity of primary power equipment in manufacturing establishments

—the overall picture is probably far better than anything that any one economist or small group of business analysts could hope to achieve—most of the forecasts are probably good, many of them undoubtedly are exceptional, any elements of poor estimates are probably exceedingly small.

As far as the picture for the individual industry is concerned, the composite industry forecasts are average judgments. The average method was the most practical one to use.

What the Committee did was to combine the forecasts in each classification in the best and fairest possible manner.

The Committee carefully points out that the individual manufacturer or other business man interested in any one line of manufacture should not take the forecast presented for that industry as his guide without doing work of his own to reinforce or disprove it.

Estimate for 1947

In the year 1939, which may be taken as the last more-or-less normal pre-war year, the aggregate value of manufactures was $56,843 millions, according to the Census of Manufactures taken in that year. The aggregate forecast of manufactures in the hypothetical postwar year 1947, with which this study deals, is $80,515 millions, at the general price level of 1939. This is an increase of 41.6 per cent.

As between the non-durable goods industries and the durable goods industries, the picture is as shown in Table II. Also in Table II the aggregate estimate is broken down into the 20 chief manufacturing groups into which the 1939 Census of Manufactures was divided.

In the complete report, the Committee presents the estimates for 290 principal industrial classifications of the 1939 Census of Manufactures. These figures are classified under the 20 chief manufacturing classifications, and present a 1939-1947 comparison, with both years shown at the 1939 price level.

In 1939, 10,078,000 persons were employed in manufacturing, excluding the self-employed. The estimated 1947 increase of about 42 per cent in value of manufactures will not be reflected in a comparable increase in employment unless the amount produced per worker is the same.

There is no question that productivity per man-hour in manufacturing has been rising steadily over many years, as a long term trend. By 1929, manufacturing output per man-hour was just about twice what it had been in 1909. In 1941, it was about 42 per cent greater than it had been in 1929. The increase from 1929 to 1941 averages about 3 per cent a year compounded, which is just about the average rate of increase since 1909, neglecting the period during and immediately after the last war.

Some people think that the war has taught such productive lessons that, after a period of learning to put wartime improvements to work on peacetime goods, our productivity per man-hour will catch up, and be as great as it would have been if there had been no war.

In the judgment of the Committee, by 1945 the output per man-hour in manufacturing will have dropped nearly to the level of 1939; 1946 will see productivity at about the level of 1945; and the estimate is that the output per man-hour in manufacturing in 1947 will increase about the 1945-46 level and will be about 6 per cent above the 1939 level.

Working Hours

In regard to working hours, the Committee is of the opinion that the hours will be just about what they were in 1939—if anything they might be a little lower. Based on these assumptions, the output per manufacturing employe is estimated as follows:

Year	Annual Output per Mfg. Employe (At 1939 Prices)
1939	$5,640
1947	$5,978

Table III. Employment Comparisons

	1939 Millions	Est. 1947 Millions	Per Cent Increase
Value of Manufactures, at 1939 prices	$56,843.0	$80,515.0	41.6
Manufacturing employees	10.1	13.5	33.6
Civilian employment	44.9	53.5	19.1

With these assumptions, and if the value of manufactures totals $80,515 millions (at 1939 prices)—manufacturing in 1947 would employ 13,469,000 persons excluding the self-employed.

This figure would represent an increase of 33.7 per cent over 1939, in which year 10,078,000 persons were employed in manufacturing, exclusive of self-employed. To sum up: Value of manufactures would be up about 42 per cent. Employment in manufactures would be up about 34 per cent.

Everything considered regarding employment, the Committee arrived at the following conclusions: If 13,469,000 persons were employed in manufacturing, excluding self-employed, then . . . the total number of employed civilians might be about 53,448,000.

All this brings us to the conclusion that we shall have substantially full employment in the hypothetical postwar year 1947. Comparison in terms of manufacturing volume, manufacturing employment and civilian employment as a whole is given in Table III.

The Committee states "we do think—and we can hardly state this proposition too strongly—that the business man should take heart from this stirring expression of optimism by a representative cross-section of American manufacturing industry. He should not necessarily accept the composite estimate made in this study, but he should give it full weight in his thinking."

Power Equipment for Manufacturing Establishments

Valuable as is the Committee's survey, it does not solve the individual manufacturer's forecast problem. It deals in averages and totals of industrial groups and subgroups thus giving only what might be termed the general trend, leaving to individual management the problem of fitting his own forecast and planning into the general picture.

In using the information and forecasts, management is cautioned that the values given in the tables are based on prices prevailing in 1939 and must be corrected to conform with the period under consideration.

Again man-hours per unit of product most likely will not be exactly what they were in 1939, nor can we expect the power used per unit of product to be exactly the same in this postwar period under consideration. These two factors result in considerable speculation as to the amount of power required for producing the estimated manufactured products required for the year 1947.

Nothing is gained, however, by standing still in the middle of the stream of progress, so the author suggests the following procedure to those manufacturers making their plans to meet the power needs of postwar demands, knowing full well that the plan can only be outlined and, to com-

plete the procedure, the manager of each establishment must rely strictly upon data gathered in his own plant regarding employment needs, power equipment requirements, and value of products.

Assume that the forecasts reported by Marketing Committee of CED are correct, the values given being based on the prices prevailing in 1939.

The percentage increase in value is given by the Committee for each industrial group and subgroup. Use the figure for the group which most closely defines the plant under consideration.

From plant records, estimate the expansion in employment necessary to meet the estimated increased production given for the group under consideration.

From the plant inventory, determine the horsepower capacity of prime movers (i.e. electric generators or engines driving factory equipment mechanically) and electric motors driven by purchased power; the sum of these capacities will give the installed horsepower capacity of the factory.

Secure from the factory sales record the value of the product for the year 1939. With this data in hand, proceed as outlined in Table IV.

These two estimates of installed horsepower requirements may not, probably will not, agree for the reasons that changes in working conditions such as hours of labor, variation in man-hour production, installation of labor-saving machinery, changes in process methods and improved plant equipment may have taken place between 1939 and 1947 which will have changed the ratios "value of product per installed horsepower" and the "installed horsepower per wage earner."

To illustrate the method and to arrive at a rough—a very rough—estimate of what the total installed horsepower requirements of the manufacturing industry might be in the hypothetical year 1947, Table IV has been prepared from data taken from the Sixteenth Census of the United States, 1940, Manufactures, 1939, Volume I, and estimates given in the Marketing Committee's report of its survey. In making his forecasts, the estimator should use data taken from his own plant records for those items indicated in Table IV as coming from the census. The example worked out here is for the entire manufacturing industry but the method employed is applicable to any plant where the essential records are available.

What the Committee has furnished is a forecast of total employment in manufacturing institutions, value of products in all groups and sub-groups of the industry based on 1939 prices, and the ratio of 1947 to 1939 values. The estimator, to use this method, must make assumptions, based on individual plant experience, as to what he expects the value of products per

Table IV. Method Suggested for Calculating Postwar Horsepower Requirements

(Total U. S. Manufacturing Industry)

	First estimate assumes horsepower requirements vary proportionately with production	
1.	Value of manufactures, 1939 (Census)	$56,843,000,000
2.	Horsepower of prime movers, 1939 (Census)	21,239,000
3.	Horsepower of motors using purchased power, 1939 (Census)	29,213,000
4.	Total installed horsepower, 1939 (Line 2 + Line 3)	50,452,000
5.	Value of product per installed horsepower (Line 1 ÷ Line 4)	1,127
6.	Estimated value of Manufactures for 1947 (Com. Report)	80,515,000,000
7.	Unadjusted estimated total horsepower for 1947 (Line 6 ÷ Line 5)	71,402,000
8.	Adjustment factor (Assumed, see text)	1.25
9.	Adjusted estimated total horsepower based on production per installed horsepower (Line 7 × Line 8)	89,250,000
	Second estimate assumes horsepower requirements vary proportionately with wage earners	
10.	Installed horsepower per wage earner, 1939 (Census)	6.42
11.	Wage earners 1947 (Com. Report)	13,469,000
12.	Unadjusted estimate of total horsepower, 1947 (Line 10 × Line 11)	86,400,000
13.	Adjustment factor (Assumed, see text)	1.09
14.	Adjusted estimate total horsepower based horsepower per wage earner (Line 12 × Line 13)	94,283,000
15.	Final estimate, total installed horsepower in manufacturing in 1947 (Line 9 + 2 × Line 14) ÷ 3	92,606,000

installed horsepower to be, and also the installed horsepower per wage earner. To assist in making these estimates, it will be helpful to plot curves comparable to Figs. 4 and 5, using data from plant records up to 1939 then resorting to the forecasts in the Committee's report for the increase in value of products for the sub-group representing the factory under consideration. Assuming no change in these ratios will give an extremely low estimate as that concedes no advancement in productive efficiency nor advancement in the use of power. On the other hand, if the recent trend in the curves is projected to 1947, the installed horsepower indicated may be higher than should be expected although developments in the use of power during the war encourages inclination toward the higher estimate of power requirements.

Of the two curves, the value of product per installed horsepower is much more variable than the horsepower per wage earner which is almost a straight line from 1919 to 1939. In making assumptions, both factors should be considered but greater reliance placed on the horsepower per wage earner.

The adjustment factor given in Line 8 is obtained by dividing Line 5 by estimated values of production per installed horsepower as determined from Fig. 4. The factor given in Line 13 is obtained by dividing horsepower per wage earner estimated from Fig. 5 by Line 10. The estimates given in these curves give the author's best judgment from all factors considered for the problem worked out in Table IV. Giving twice as much weight to horsepower per wage earner as to value of product per horsepower, Line 15, the final estimate is calculated by adding Line 9 to twice Line 14 and dividing by three. Thus we arrive at an estimated total installed horsepower in manufacturing establishments in 1947 of 92,606,000. This represents the sum of prime mover horsepower plus the horsepower rating of electric motors driven by purchased power which is an increase of 85 per cent over the census figures for 1939.

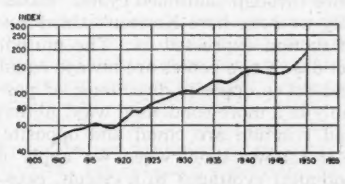


Fig. 3. Output per man-hour in manufacturing

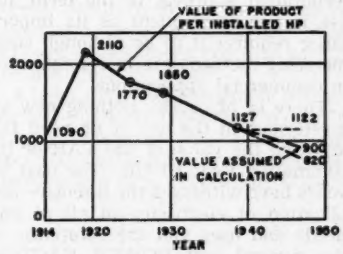


Fig. 4. Trend in value of products per installed horsepower

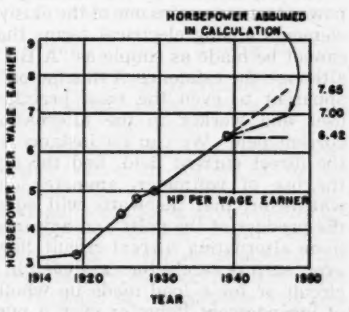


Fig. 5. Trend in installed horsepower per wage earner in manufacturing

Countless thousands of words have been written in hundreds of books and articles on the general subject of power factor and yet, as Mr. von Dannenberg points out in this article, the meaning of power factor remains one of the elusive elements among electrical terms; there are many men in the field who still do not understand what the term means. In recent years there has been a trend toward the use of the VAR, representing the unit of reactive power and thus avoiding the need for an understanding of power factor. The VAR, however, seems little better understood than power factor, even though this unit has been in existence for many years. In view of the general confusion existing among engineers regarding the meaning of these various terms, Mr. von Dannenberg has written this article on the subject. It is one of the clearest discussions we have seen and we are glad to have the opportunity of presenting it. Mr. von Dannenberg is an electrical engineer with a rich background of experience both in this country and abroad, and his consideration of the subject is authoritative.

POWER FACTOR OR VARS

By C. O. von Dannenberg

THE INCREASED use of capacitors for the control of power factor and regulation of voltage have long indicated the need of meters for observing the circuit conditions, which will in turn permit the application of corrective measures without or with a minimum of calculation.

At the meeting of the International Electrotechnical Commission in 1930, it was voted to adopt "the name or term of VAR for designating the unit of reactive power." Briefly 1 var results from 1 volt acting in quadrature (90 degrees) with 1 ampere. Even though almost 15 years have passed since this meeting giving international approval to the term, its use is not as frequent as its importance requires it to be although such metering methods are in common use in commercial applications.

There is, of course, nothing new or mysterious in the use of or need for knowing the value of the VAR or its summation VAR HOUR. The past 50 years have witnessed the intensive application of electricity to all of our needs and uses and the reference to the derived unit POWER FACTOR has continued even though its limitations have long been recognized.

The explanation of the meaning of power factor remains one of the elusive elements among electrical terms that cannot be made as simple as "A B C" although the existence of this factor is apparent to even the most practical user and worker in the alternating current field. We can for instance, in the direct current field, find through the use of voltmeter, ammeter and wattmeter, that the watts will equal the product of the volts and amperes; in an alternating current circuit, however, such is rarely the case even in a circuit or for a load made up wholly of incandescent lights or even a pure resistance load. When the load measured is made up essentially of motors and transformers the watt reading may be very much less than the product of the volts and amperes and the ratio of watts to the product may be a low one or as it is customarily given, a low percentage. Various analogies have been suggested but since the true nature of electrical phenomena are conjectural it seems sufficient to state that any circuit having a magnetic coupling or which consists of some condensive capacity equipment will have a power factor of less than 1 or 100 per cent, in commercial terminology. We have then in any alternating current circuit volts, amperes, and watts, all readily measured; and from the ratio of the watts to the product of the volts and amperes is calculated a value which is known as the power factor.

Basic Principles of Power Factor

Actually the basic essentials concerning power factor and its pertinence to alternating current phenomena can be readily indicated experimentally. For the system including a conductor and a magnetic field there is no effect when the conductor or the field move or are produced in a parallel direction; the field may be stationary in a continuous one-way direction with the conductor revolving or the conductor may be stationary and subjected to the influence of a field created by an alternating voltage varying periodically in forward and reverse directions through continued cycles. Basically we have here Newton's third law of motion expressed as: The mutual actions of two bodies are always equal and act in opposite directions; or possibly in a more condensed way: Action and reaction are equal and opposite.

It follows then, when we apply a potential (voltage) to a circuit, causing a current to flow we produce a magnetic field which in turn induces a potential (voltage) in the conductor, opposed to the impressed potential causing the flow. While for direct current this effect is of short duration slowing up the rise of the current when first applied and tending to continue the flow when the impressed potential is removed, the periodic variation in alternating current circuits makes the effect a continuous one. It follows then: the impressed (producing) potential in a perfect magnetic circuit gives rise to a reacting potential directly opposed to it or lagging 180 degrees behind it and 90 degrees behinr the current flowing; hence the impressed potential (the applied circuit voltage, as indicated by a voltmeter connected to it) leads the current by 90 degrees. Actually no circuit is either completely non-magnetic or completely magnetic hence the angular relation of voltage and current is less than 90 degrees as for instance unloaded transformers and induction motors indicating angles as low as of the order of 78 degrees or even less with correspondingly low power factors. Where we have a capacity effect as the major factor we obtain the phenomenon of leading power factor since the flow of current in a perfect capacitive circuit is maximum when the potential is zero; in other words, it leads the potential by 90 degrees. A simple illustration is the one of using direct current for testing cable continuity where a battery and telephone receiver are used, with a circuit made up of two insulated conductors, applying the potential there is indicated a current flow by a click in the receiver when the cable is being charged but ceases when the initial charge is completed, in fact if the insulation was perfect it would continue to hold the charge indefinitely. Removing the battery from

the circuit and applying the receiver alone we obtain a click due simply to the charge remaining in the cable being discharged through the receiver.

Where synchronous motors are concerned, designed for purely power factor and voltage control, angles of lead as low as 89 degrees (2 per cent power factor) are not uncommon. A similar phenomenon is that of a long unloaded transmission line; we have for instance for the average 66,000 volt (between lines) 3-phase circuit an approximate power factor per mile of line of something of the order of 2 per cent leading indicating an angle of the order of 89 degrees.

Use of Meters

The foregoing is essentially a summary of known and readily checked information which can be demonstrated experimentally and verified through tests; but continuing further other elements and characteristics develop, indicating approach in another way.

We have the basic symbols:

E for voltage, I for current, W for watts from which follow:

$E \times I$ or voltamperes (VA)

Power factor (PF) $= \frac{W}{EI}$ (for 1-phase circuit) and

$\frac{W}{\sqrt{3}\,E\,I}$ for a 3-phase circuit (assumed balanced)

The foregoing are in decimal values which in usual practical problems are multiplied by 100 to give them in per cent and which are usually given in power contracts and other discussions.

The measurement of power factor presents no practical difficulties if only approximate values are desired; all methods involve the use of voltmeter, ammeter and wattmeter, the last named being a 1-phase 2-coil meter for a 1-phase circuit; one 4-coil meter polyphase or two 2-coil meters for a 3-phase circuit. For the 3-phase circuit when using two 2-coil meters the readings are never exactly the same except at 100 per cent power factor which is essentially a theoretical condition and one rarely found in practice. For a balanced 3-phase circuit a single 4-coil meter may be used alone and the power factor calculated from the ratio of the two single phase readings.

There is in actual use what is known as a polyphase balanced power-factor indicator consisting of one current element and one potential element; the potential element receives as its energizing potential the voltage which is the resultant of two line-to-line voltages using the common connection for the line from which the current is derived and so connected that at 100 per cent power factor the resultant fields are at 90 degrees resulting in zero torque and the pointer attached to a moving element of iron takes up a calibrated position on a scale marked 100 in terms of power factor or the resultant angular relation of the two fields produced for the particular circuit condition. It is readily seen, if the voltages and currents are not well balanced the value of the resultant may differ from the value obtained by other means. For a 1-phase instrument with 2-coils the potential circuit has reactance, virtually a choke coil with an iron cure, added to it, adjusted to indicate 100 per cent power factor with a wholly resistance load. For a 2-phase circuit a meter with two current and two potential windings has been used the potential elements being connected to the opposite circuit from which the current is obtained, making it essentially the same as a 4-coil wattmeter.

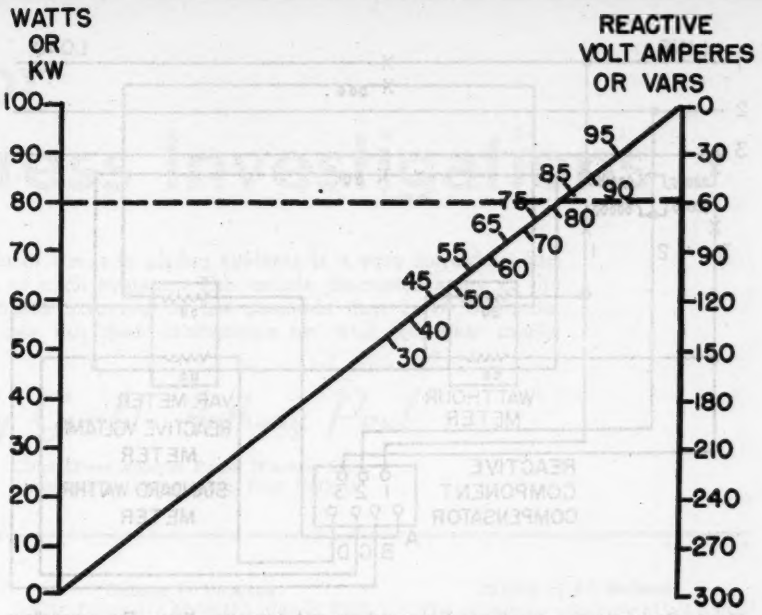


Fig. 3. Simple charts for determining VARS from Power Factor and Watts or Kilowatts

$$\text{Vars} = \sqrt{(\text{kva})^2 - (\text{kw})^2} \quad \text{or} \quad \text{kw} \times \text{tangent of angle}$$

The scales used in making up charts such as this will depend on the range of power factor and vars concerned. If given in the same value for both scales or simply in a percentage it is at once clear that for 70.0 power factor the value of kw and vars are equal, so for lower ranges the var scale must be extended

Use of Vars

Actually when we make practical applications we find limitations which make the use of VARS instead of power factor a desirable one. As previously stated the term power factor is a derived one and the meters available for its direct measurement are limited in their application to balanced circuits or those very nearly so. The operating situation usually experienced is that of adding or reducing some value of VARS, either to change the power factor or for voltage control. The handling of such situations in the simplest and most effective way is of most pertinent concern. The conditions require the availability of meters measuring volts, amperes, watts and either power factor or VARS; since the conventional power factor meter available is reasonably accurate for balanced conditions only and VARS can be determined with a greater degree of accuracy, the use of the latter is more desirable. In addition a change in the system or load conditions, as previously stated, requires the addition to or subtraction from, of a value of VARS, hence a knowledge of what the value of VARS is and what it should be for the changed condition, will indicate the value of VARS to be added or subtracted to obtain the condition required. While it is possible to make calculations rapidly, using the slide rule and tables, more practical means are available.

A brief review of the simple mathematical elements concerned seems in order at this point. We can represent circuit conditions involving volts and amperes and power factor as follows:

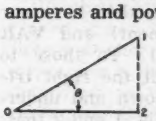


Fig. 1

Fig. 2

For Fig. 1: O1 represents the impressed circuit volts, leading the current O2 by the angle θ; for Fig. 2, O2 represents the impressed volts, lagging behind the current O2 by the angle θ. Fig. 1 represents the conventional setup for a circuit with lagging current and Fig. 2 with leading current. As previously explained the power factor can be calculated when the readings of watts, volts and amperes are available and from this we obtain the values of the angles θ,

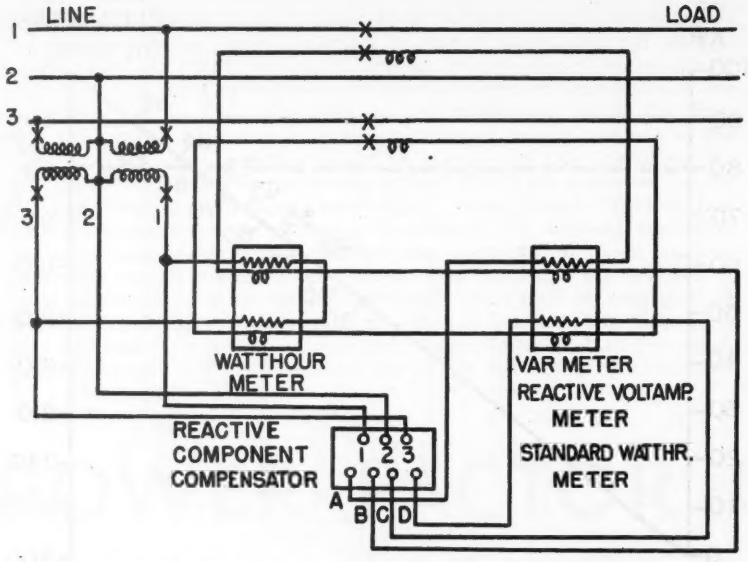


Fig. 4. Conventional connections of a watt hour and varmeter. Note: The connections indicated for the varmeter are conventional for normal forward rotation for lagging power factor with a phase sequence of 1-2, 2-3, 3-1

or what is more needed for practical application, information leading us to the value of VARS which is the useful one. The value of watts in either Fig. 1 or 2 is equal to O2 times the value of O1 or O3, in phase with it, or acting in the same line. We have from elementary trigonometry, to get the value of O1 or O3 in phase with O2 (O1 cos θ) or (O3 cos θ) cos θ, being equal to O2 ÷ O1 or O2 ÷ 03; to complete the group we require the value of the VARS as was defined at the beginning, namely, the element "acting in quadrature (90 degrees)" with the amperes. Briefly the VARS in Fig. 1 and 2 can be represented by the values 1-2 and 2-3 respectively, and since the amperes O2 are common to the system, the position of volt-amperes is represented by O1 or O3 and in turn 1-2 and 2-3 can be calculated from O1 sin θ or O3 sin θ Any trigonometrical table gives the corresponding cosine and sine values for any angle and we then have our watt (power component) and VAR (reactive component). To those to whom the features of the right triangles are better known and understood it follows for Fig. 1 and 2 that:

$$1\text{-}2 = \sqrt{(O1)^2 - (O2)^2} \text{ or}$$
$$2\text{-}3 = \sqrt{(O3)^2 - (O2)^2}$$

although using the power factor (cosine) and reactive factor (sine) values enables more rapidity and accuracy in calculation to be gained. It is also possible to use a graphical chart which permits rapidity and almost instant results to be obtained. The accompanying chart Fig. 3 illustrates a graphic method for obtaining power factor, vars or watts when the two other quantities are given. If for instance we have a value of 100 watts (or kw) at 55 per cent power factor, we obtain the vars by placing a straight edge, intersecting 100 on the watt scale and 55 on the power factor scale and the extension to the var scale indicates a value of 151 vars; or we can obtain as is evident the watts from the vars and power factor and the power factor when given watts and vars. The graph can be made up to suit any load conditions expected; the one given was made simply to show a fuller range and is based on the relations given in the appended diagrams. If for instance, as is often the situation, a close range of power must be maintained the expected watt or var scales can be longer for the values concerned and so make possible very close readings. It is, however, necessary to point out an important detail a fundamental one which brings out more clearly the desirability for using VARS rather than power factor. An actual example will illustrate the foregoing statement. At 100 per cent power factor the reactive factor (or VARS) is zero; at 90 per cent power factor reactive factor is 43.6 per cent or in other words with a load of 100 kw the vars are 48.4 kva. This relation can be checked from Fig. 3 or can be calculated as follows:

$$\text{kva} = \text{kw} \div \text{power factor}$$
$$\text{or} \qquad 100 \div 90 = 111.1$$
$$\text{rkva (vars)} = \sqrt{\text{kva}^2 - \text{kw}^2} \text{ or}$$
$$\sqrt{(111.1)^2 - (100)^2} = 48.4$$

This shows for a 10 per cent power factor change there is a change 48.4 ÷ 100 or 48.4 per cent on the kw base or to state the conclusion in another way, for a relatively small change on a power factor scale we have virtually five times the change on the VAR scale; this can also be observed on the scale of the power factor indicator where there is much less change as 100 per cent power factor is approached, so a power factor reading close to 100 per cent and particularly between 95 and 100 is uncertain for the conventional type of meter available. And in addition, as previously stated, the meter is energized through the resultant fields due to two voltages and one current, which introduces another uncertain element in the indication.

Use of the Varmeter

We have, on the other hand for the varmeter as in conventional use and agreed upon as a commercial measuring instrument, a duplicate of the wattmeter with two current and two potential elements, with the same scale. It is, however, necessary to provide some auxiliary equipment to establish the relations required to give the value sought after, namely, VARS. This is known generally as a phase shifting transformer or, possibly better, as a reactive component compensator. Fig. 4 indicates the conventional connections for a watt hour and varmeter. Fundamentally the reactive component compensator introduces into the varmeter a voltage shifted 90 degrees from that in the watthour meter hence the indication or registration varies in this meter with the power factor of the load.

Theoretically the varmeter should indicate a value proportional to: EI sin θ where the power factor meter indicates EI cos θ. However, since there is no commercial meter yet developed for this purpose the conventional method in general use is as indicated, although it is clear the voltage impressed on the potential coil of the varmeter is made up of or the resultant of two other voltages. The vector relations need not be given here but the relative values of the component voltages are 57.7 and 115.5 per cent, which when combined in the angular relation give the required 100 per cent value impressed upon the meter potential coil. Incidentally, it is also necessary to take into account the phase sequence (incorrectly termed phase rotation) when connecting the varmeter. This and other pertinent details are clearly given in the instructions issued with each meter and need not be given here.

A method used for obtaining a value or reading which can be changed to vars through the use of a calculating factor is available. This consists in simply cross-connecting the potential coils of a watthour meter so the voltage, see Fig. 4, received from lines 1-2 is impressed on the coil normally receiving voltage from 3-2, and putting voltage 3-2 on the meter coil normally receiving voltage 1-2. This method however, requires the use of a multiplying factor 3 ÷ 2 or 0.866 to give the correct value of vars. The only reason for giving this method is the possible situation when an immediate result or value is required and the compensating transformer, a special type of auto transformer, is not immediately available. This method is not recommended for general use as it is not unusual to receive a reading

(Continued on page 104)

The Aims of Pipe Stress Investigations

The determination of stress in piping systems is a very important factor in the design of such systems. This article discusses some of the underlying principles involved in the methods that have been developed and points out their limitations as well as their merits

By Gerald Anthony Paul

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Instructor in Mathematics, Pratt Institute

THE AIMS of the pipe stress investigator are to insure the most safe operation of high temperature and high pressure piping and equipment, consistent with the economy of materials. It is his responsibility to insist that every length of pipe performs maximumly. He knows that every heated line exerts a potential force of 190-psi of cross-sectional area per degree F difference in temperature. Consequently, methods and devices must be utilized to prevent the destruction of equipment and injury to operators. In order of common usage, changes in the direction of pipe runs, expansion loops and bends, corrugated pipe and creased bends, expansion joints and hinged joints, are universally employed to absorb expansions.

If frictional losses in flow and the vibrations of equipment are not controlling factors, a few additional feet of plain pipe is by far the cheapest installation. The inherent elasticity of steel makes it possible to design a pipe run so that it will behave much like a spring, compressible or extendable. While analogous in operation, the determination of stresses and strains in a spring, are much simpler than the same investigation in pipe. A pipe line is a space system whose members lie in one, two or more planes. As the line becomes more complex, the amount of labor involved in an analytical solution for moments and reactions employing the basic mathematics of mechanics becomes excessive. Moreover, when the cross section of a pipe line is not uniform, and where the system consists of three or more branches, calculation problems are insuromuntable. Many ingenious men, as Sabin Crocker, C. T. Mitchell, and S. W. Spielvogel, have devised systems for the analysis of pipe lines in space, yielding results of a precision commensurate with the expenditure of effort and good engineering judgment.

Change in Direction

The generally accepted idea is that a change in the direction of a line constitutes the basis of flexibility. Furthermore, a unit force applied to any frame will produce a unit moment. By the conjugate beam theory, moments of unit moment areas are calculated, which in turn yield unit deflections. The combined effect of the unit forces in three coordinate planes are then summarized, forming constants in units of pounds x feet cubed, called "shape constants," "flexibility constants," or "moment areas." Since the relationship between deflection and force or stress is proportional to these constants, it is a simple matter to equate the expansion of the pipe system with the deflection and compute by direct ratio the force of unit stress, generated by the heated pipe system.

Of the manifold methods, the Graphic-Analytical System of C. T. Mitchell is the accepted standard of many companies for the computation of stresses and forces generated by the usual run of high temperature, three dimensional pipe lines. The justification for this adoption lies not only in the excellent operational experiences of many years, but also in the realization that if stresses are found to lie within safe limits, and if the magnitude of the resultant forces are such that terminal vessels, or supporting structures are not overloaded, the requirements of a pipe stress investigation are satisfied. In support of competitive methods which claim to be exact, it has been argued that the "Mitchell Method" may yield results with a 25 per cent inaccuracy, or worse. The author will agree that for unsymetrical, compound and redundant pipe layouts, Mitchell's fundamental hypothesis concerning the direction of the neutral axis, is perhaps untenable. Nevertheless, compensating conservatism and the speed in attaining a general picture of pipe behavior, more than offsets the inherent discrepancies in this process.

Fallacy of All Methods

The elementary fallacy of all methods lies in the basic assumption that the ends of a pipe line are firmly secured against translation and rotation. That the true end condition lies somewhere between complete fixation and the freedom to rotate, is obvious. But, to estimate the percentage of end fixation and attempt to plot corresponding points of contraflexure in the piping system, is an unjustifiable refinement, leading to cumbersome calculations, prohibitive in their mathematical complexity. Therefore, if only for convenience, the fixed ended pipe line is held compatible with the probable state. This is conservative since it can be shown that the computed stress for a line considered fixed, is twice that for the same line assumed hinged. Among other things, calculations based upon the Mitchell method are also on the safe side, inasmuch as the omission of the flexibility gained by torsion and the flattening effect of curved sections, vitiates, to some degree, the liberal predetermination of the points of least moment.

Whether an "exact" method is employed or not, the primary consideration is neither to establish a precise stress, nor a definite reaction, but to determine in what range of values the figures lie. Stresses up to or beyond an allowable limit indicate insufficient flexibility, and stresses found to be in the hundreds or low thousands of pounds per square inch indicate more material has been used in the layout than needed for adequate safety.

Allowable stresses are determined by laboratory experiments under conditions far more favorable than those experienced in practice. Thus, it is clear then, that a large measure of engineering judgment must be exercised when computed stresses approach the allowable, particularly since contingencies beyond the control of the designers, as initial variations from the ideal pipe and mis-

alignment of field supports, are uncertainties reasonably ignored. While it is true that failures in compression members are the most frequent causes of structural collapse, nevertheless compression is not often critical in pipe stress analysis. On the other hand, tensile stresses encountered in flexure are aggravated by the axial stress produced by internal pressures. Moreover, any intense concentration of stress of a high localized character will tend to relieve itself by plastic flow, and at worst cause permanent set in the line rather than fracture. The real danger lies, however, within high moments at positions in the line occupied by flange joints and valves. It is here that even small displacements will unbalance the gasket pressure, causing flange joints to leak, or will prevent the proper seating of valves, with resulting wire drawing in the case of high pressure steam.

It is not at all uncommon for a designer to "loosen" a line figuring well within stress requirements, because he has found excessive end forces. High pipe reactions on towers or condensers will deflect the shells, displace tray supports and foul baffles. Turbine manufacturers limit the permissible forces on casings to zero pounds. Since this is an impossible restriction, many analysts use a loading of 100 lb maximum per peripheral inch of nozzle. A study of deflection formulae reveals, that for equal conditions, *stress* is the governing factor in small diameter pipes, but for large diameter lines, *force* controls. It should be noted, too, that stress is independent of pipe-wall thickness, and constant for reciprocal variations of force and deflection. Since force and deflection are directly proportional, for any given problem, the effects suffered upon terminal equipment or fixed supports should be investigated whenever a pipe schedule is increased.

What Method to Use

The question of "how to consider a pipe run," or "what method to use," arises frequently in pipe stress determination. A few considerations will dictate the procedure. The ends of all shapes terminating at equipment or at rigid anchors may be regarded fixed. Single plane, uniform and symmetrical runs, having but two anchors, including 90 degree bends with tangents, may be computed accurately by the "Mitchell Method." Systems in several planes may be investigated for range of stress values by "Mitchell," but for the strictest economy of material, especially when expensive alloy pipe is used, an analysis by the "Elastic Center" or "Moment Area" methods will prove more exact. Multi-branched lines, and runs composed of several pipe sizes are more easily examined by breaking the shapes into elementary units and summarizing the individual effects by the methods of virtual lengths and super position. A fair familiarity with two or more methods of stress analysis, together with an understanding of the basic approach, will overcome the calculation difficulties in any seemingly impossible arrangement of pipe lines.

It may be required to ascertain, merely, the adequacy of a section of pipe consisting mainly of a large quarter-bend. There are tables listing the permissible movement and resulting force at a stress of 12,500-psi for quarter-bends up to 150 inch radii, in all standard sizes of pipe. A glance at the chart will probably determine the need for further investigation. "L" shapes and loops may be quickly analysed from published nomographs. The author has found the use of the "Hardy Cross" Moment Distribution system and the fundamental conjugate beam theory measurably helpful when calculating the effects on systems with many branches and redundant restraints.

There are a number of typical cases where one system of computation definitely takes precedence over all others. Such a problem might involve a large vapor line emanating from the top of a fractionating tower and terminating at an anchored condenser. The stress in this line will be most critical during the "start-up" or "steaming-out" operations of the plant. The tower is considered hot, while the line is cold. Hence, the line must be sufficiently flexible to absorb the expansion of the tower from its lower tangent line to the vapor nozzle. The "Mitchell Method" would be inadequate for this investigation. Consequently, the method of super position would be chosen to give the proper weight to the moment reversal in stretching the vapor line to accommodate the tower expansion. Herein is a condition analogous to the stretching of a spring, where a line, absorbing only an external movement, behaves differently from the heated "fixed-ended" space system.

While it is not intended to extol the merits of any one system of pipe stress analysis, nevertheless, each has its place among the tools of the prudent designer. When it comes to weigh in the balance the importance of precise calculations and extensive research with the overall economy of materials, the experience and judgment of the analyst will be reflected in his expenditure of engineering effort. More true in a science than in many other phases of human endeavor, the ends justify the means.

Power Factor or Vars

(Continued from page 102)

without reference to the reduction factor involved so it becomes necessary to have a recheck.

The foregoing portion has attempted to review in an explanatory way the need or preference for using VARS instead of power factor. The practical use is relatively simple through prepared tables, curves or charts which makes the application far easier. The straight line method as per Fig. 3 is probably the simplest to use and a result is made available without calculation with a minimum of effort. Assume for instance we have a 1000 kw load with a power factor of 80 per cent which it is desired to change to 90 per cent, from Fig. 3 we lay a straight edge between 100 on the kw scale in line with the 80 per cent mark on the power factor scale which prolonged to the right intersects the var scale at say 750 on a proportional basis; we then by the same method between 100 and the 90 per cent mark which indicates say 480 on the var scale. The corrective vars to be applied will then be 750-480 or 270. This may be checked in two ways as follows:

For 1000 kw at 80 per cent the total kva will be 1000 ÷ 0.8 or 1250; from a trigonometric table for a power factor (cosine) of 0.8 the reactive or var factor (sine) is 0.6; then the vars will be 1250 x 0.6 or 750. In a similar way the tangent of the angle whose cosine is 0.8, is 0.749 or 749 which is less than one per cent of the other value. At 0.90 power factor, the reactive or sine is 0.436 the kva are 1000 ÷ 0.9 or 1111 and vars are 1111 x 0.436 or 485; then we have 750 — 485 or 265 for corrective vars.

The vars may also be calculated using the formula: Var = 1250^2 — 1000^2 or 750 at 0.8 power factor; then at 0.9 the kva will be 1000 ÷ 0.9 = 1111; and the vars will be as before, 1111^2 — 1000^2 or 484 which checks with the scaled value of 480. The corrective vars from the lengthy arithmetical method, the rigorously correct one, will be 750 — 480 or 270, the same as obtained by the straight line method and with practically no calculation. It is clear with scales made up to suit the range of load in kw, vars and other known factors from actual operating knowledge. They can be drawn and divided to give close readings, within one per cent or less.

Summing up the general details of the discussion vars may be said to be more desirable to use than power factor for reasons as follows:

1. The accuracy of the method is the closest available with commercial measuring devices available for both indicating and integrating meters.

2. It is a standard method approved by convention and is in universal use.

3. It uses standard watthour meters.

4. It is simple to apply and can if necessary, and with care, be used without a compensator.

5. It gives information which, with the use of the chart or tables shows at once without calculation what is necessary to be done to obtain any required condition.

The
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ANDREW W. KRAMER, EDITOR

☆

Why Not to Marry an Engineer

(Psalm to an Engineer's Sweetheart)

By Leslie Nielsen

Verily, I say unto ye, marry not an engineer:
For an engineer is a strange being and possessed of many evils.
Yea, he speaketh always in parable which he calleth formulae,
He wieldeth a big stick which he calleth a slide rule,
And he hath only one bible, the hand book.
He thinketh only of strains and stresses, and without end of thermodynamics.
He showeth always a serious aspect and seemeth not to know how to smile.
He picketh his seat in a car by the springs thereof and not by the damsels.
Neither doth he know a waterfall except by its H.P., nor a sunset except that he must turn on the light, nor a damsel except by her weight.
Always he carrieth his books with him, and he entertaineth his sweetheart with steam tables.
Verily, though his damsel expecteth chocolates when he calleth, she openeth the package to discover samples of iron ores.
Yea, he holdeth her hand but to measure the friction thereof, and kisseth her only to test the viscosity of her lips, for in his eyes there shineth a far-away look that is neither love nor a longing look—rather a vain attempt to recall formulae.
Even as a boy he pulleth a girl's hair but to test its elasticity;
But as a man he deviseth different devices.
For he counteth the vibrations of her heart strings, and seeketh ever to pursue his scientific investigations.
Even his own heart flutterings he counteth as a measure of fluctuation, and enscribeth his passion as a formula,
And his marriage is a simultaneous equation involving two unknowns and yielding diverse results.
Verily, I say unto ye, marry not an engineer.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

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There Ought to Be a Law—

By WILLIAM S. WHITE

I DON'T know whether other engineers who may read this will agree with me or not but it's my observation that when a "junkpile" type of plant finally reaches the end of its tether, the management—mainly responsible for the existing state of affairs—usually decides, that all that is needed is a good engineer with plenty of experience, and in a short time the innumerable errors and mistakes made in years past, will be corrected and adjusted without involving much time or expense. With all the arguments advanced today in favor of free enterprise, one may asked to be excused for harboring doubts about the whole thing, after an experience such as I had recently. This experience made quite an impression upon me and since I had had others similar to it before, I made a resolution to make a much more thorough investigation than I did on this occasion, before accepting a position as chief engineer or master mechanic.

Owing to poor health, I had been idle for some time. When I was well enough to think of going back to work, a coal mining firm invited me to take charge of the power plant and the mining machinery at a place about 150 miles due west of the City of Edmonton, Alberta, Canada. The plant was represented as having been rebuilt, and practically ready to get started under steam. The original plant had been destroyed by fire about a year previous. Having in mind a more or less new plant built in accordance with modern principles of design, and having had some experience in mine plants, the offer appealed to me as a desirable opportunity.

First Impressions

When I arrived at the place and looked over the supposedly rebuilt plant under the guidance of the manager, I had to pinch myself as I listened to him averring that in a few days I should be able to get up steam and have a 500 kva unit in operation. The direct-connected compound, vertical engine of this generating unit stood, like a monument in solitary grandure on a square block of concrete four feet above the surrounding debris in the engine room.

A prize exhibit, of which the manager was very proud, was the forced draft fan, which he had caused to be rebuilt out of a ventilating fan which had gone into disuse. The fan was certainly large enough, and had been installed so that it discharged downwards, and practically at right angles to the horizontal wind duct leading through the bridewalls of the four 150 hp, hrt boilers, with a damper control in each ashpit. Properly, the fan should have been turned around so that the discharge swept down and under the fan base into the duct. It turned out later that the fan had to be reversed, because there was no one who could reverse the operation of the vertical steam engine direct connected to the fan, and it would have been too inaccessible, and inconvenient to place the engine on the other side of the fan. On the other hand it is possible from what I was to find out in other things, that the direction in which the fan was to revolve was not understood when the fan was put in place. I was informed that the previous fan, which was rendered useless by the fire, had been too small and the much larger fan now in place would give much more draft. Previously the draft had been insufficient. As the duct was the same size as before, only 16 in. square, having been originally installed for two boilers and extended to take in two more boilers later, it was hard to see much advantage taking into consideration other factors.

The Smoke Goes Up the Chimney, Maybe

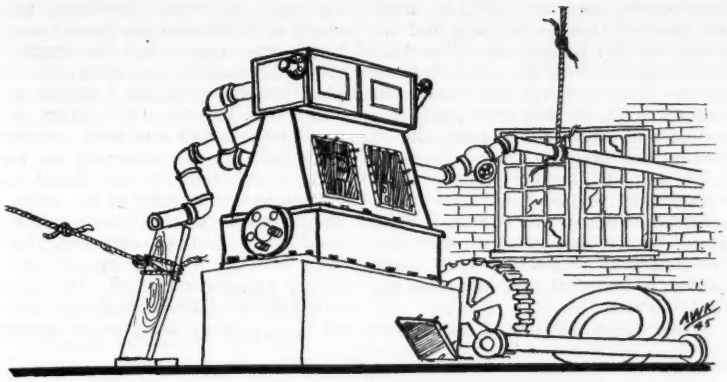
The boilers and settings had survived the fire but very little had been done to them in the way of repairs, although much might have been done in improvements. The individual stacks, however, had been replaced by a breeching supported on the boiler fronts together with a single short stack, which was 40 ft high above the grate surface. The original stacks had not been any higher, and this at an elevation of 3,800 ft above sea level. It was quite plain that the whole matter had been confused with an induced draft installation, and that if sufficient air could be forced into the fires, in some mysterious way, the gases of combustion would be forced through the combustion chamber, into and along the 4 in. tubes to the breeching and up the stack.

The small vertical, enclosed steam engine for driving the draft fan was in the course of being re-assembled when I was introduced to it, and told it would soon be ready. A new valve and piston rod had been made up and considered as all the repairs necessary. The cylinder and the piston with its distorted rings showed very little relation to one another, and this was the case also with the circular slide valve and its bore or chamber. The valve was so loose a fit, that by tilting it sideways, it would lock on the port

There ought to be a law to prevent anything like what is described in this article happening to any engineer. This is the sort of thing that drives engineers nuts and yet it goes on every day in countless piles of junk called power plants throughout this whole great land. Mr. White, the author of this painful narrative, it may be recalled wrote "Twenty Years at Ponoka" which appeared in the November, 1944, and February, 1945, issues. Mr. White's twenty years at Ponoka were bad enough, as we pointed out, and after his trying experience there it might seem strange and ironical that he should now encounter a situation like this but as we said when we presented the Ponoka story, these are not isolated instances—they prevail in countless other so-called plants throughout the country. Just because an engineer has a license, management assumes that he should be able to assemble any odd collection of scrap into a power plant, at practically no cost and with little or no help. When questions of cost or safety come up, the engineer's experience and technical knowledge count for nothing.

If he can't put an out-dated slide valve engine that has been laying on the junk heap for ten years into perfect shape with a screw driver and a monkey wrench, why does he go around posing as an engineer? That is the attitude of many so-called managers. When an accident occurs, however, then it is another story, then the engineer is to blame. Why didn't he do something about it?

Read the article by R. L. Brown, "The Chief—He Don't Know Nothin' About Engines" which was presented in these pages in the March, 1945, issue for a tragic example of what happens through the criminal negligence and incompetence of some managers. Perhaps engineers are considered as "expendable" but that is poor solace to the engineer who has to make a living. Mr. White did not write the title we use at the head of this article—he called it, "A Peculiar Power Plant" which was putting it mildly. In our opinion they should bury it—it smells, and that, also, is an understatement.



The compound vertical engine stood like a monument in solitary grandure on a square block of concrete

edges. To make the engine function at all, the cylinder had to be bored out as there was a depression worn in the cylinder wall at one end about 3 or 4 in. in diameter, and about ⅝ of an inch deep that looked as if it had been caused by wet steam impinging on it for a long time. The boring of the cylinder was done on an ancient type of lathe, which had passed through the fire, and the result left much to be desired in the way of a finished job. The piston was built up by bronze welding and turned off to a fit, and the ring grooves squared up to take a new set of rings that had been procured from an outside machine shop on dimensions given. However when it came to the boring out and refitting of the valve in the steam chest, the manager would not allow this, as too much time had been wasted on the cylinder. Furthermore, the engine had run the fan all right before the fire, other statements to the contrary.

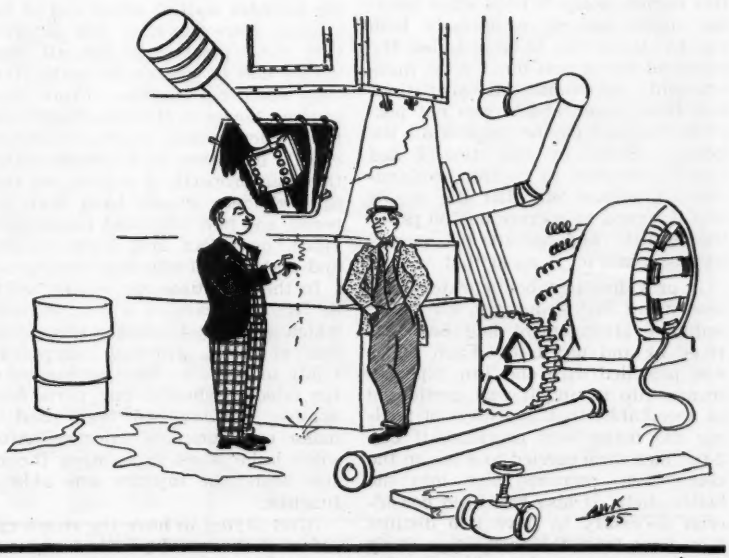
After some further delay in fixing up the geared oil pump for lubricating the engine bearings, which at best could only operate for a short time as the operating mechanism was practically worn out, the engine was assembled and tried out. There was a steady blow of steam from the exhaust pipe between the exhaust beats of the engine. It was apparent, however, that the engine had been in much worse condition when in operation previously so this steady blow made no impression, and it was conceded that the engine was using less steam since the throttle had not to be opened up so much to get the revolutions required.

As has been said, very little repairs had been done in the boiler room and although there was evidence that one of the boilers had been overheated owing to lack of water during the fire, nothing had been done about it. Work had been proceeded with to construct a header extending from the branches on the boilers into the engine room, and as far as the electric generating unit mentioned. This header had been reconstructed from pipe salvaged from the fire including fittings. As the header was carried forward into the engine room (and by appearance it must have been a painful process), an offset bend and rise had to be introduced to bring the header in line with the building. Apparently no one could explain why it had been found necessary to carry the header so high up behind the boilers and then along one side of the engine room, over the switchboard, and a branch from it, over the generator and engine center line to the engine throttle. No provision had been made for supporting or anchoring the header and it was temporarily supported with timber and boards where most convenient to do so. No consideration as to suitable places for supporting columns or anchorage had been taken into account. In meeting this difficulty, objection was taken to the substantial arrangement that had to be made, as not being entirely necessary, but since the Provincial Boilers Act and Regulations had to be observed in the breech, very little fault was likely to be found with the support finally given the header.

The engine as mentioned had been installed on the top of a square block of concrete like a statue, in preference to sinking the base of the alternator into a pit. The engine ran at 360 rpm. From the appearance of the foundation, it certainly had no relation to the engine builder's idea of a safe and suitable foundation, as I had experience in installing engines of this same type. The engine had been purchased second hand, and although some time had elapsed between its purchase and installation upon the foundation, and notwithstanding the fact that it had been hauled by railway through two important cities where it might have been put into first class shape, nothing had been done to it. I pointed out to the management, that this engine was not at all in reliable condition and as it had to be entirely depended upon for power, it should have had, and would need quite an amount of repair work, which could not be done with the small machine shop facilities provided on the job. I was told that a number of persons had been asked at the place where it was purchased as to its condition, and the replies had been, that the engine was in good shape when shut down two years before. As the manager was determined to have it in operation, after some delays steam was raised in two boilers, and preparation made to blow out the header and branch up to the engine throttle, although the manager hardly thought this necessary. However, the flange joint above the throttle was disconnected and the joint spread apart to allow a piece of sheet iron to be inserted to catch any cuttings and dirt. When the line was blown through the amount of debris diverted by the sheet iron even satisfied the manager.

Engine Visible Through the Clouds

Eventually with steam on, the engine was brought up to speed with the



The manager averred that I could whip it into shape in a few days

engine hardly visible through the clouds of condensed steam issuing from piston and valve rods, a condition which was to be expected by the visible wear on the rods. The worst feature was the leakage through the rod scrapers into the crankcase, and while the scrapers on the piston rods were adjustable, the valve rods had a solid scraper edge and combined guide of some depth. The rods had become so loose in these guides, that the rods rocked visibly. As the metallic packing of the valve rods was leaking badly, this had to be taken out, and was found to be in many pieces and of further little use. From a box of miscellaneous packing sent with the engine, enough odd pieces of previous used sets were derived, to make up two sets of packing for the valve rods, which reduced the blowing of steam considerably, but enough moisture still found its way along the worn rods into the crankcase to emulsify the oil.

To maintain the lubrication of the engine, a regular system of withdrawing some oil from the crankcase and putting in a fresh supply had to be used. The emulsified oil withdrawn was renovated for further use with a steam coil in a barrel as the first expedient available. There was evidence enough that this system had been used when the engine was in use with its previous owner.

It was pointed out to no avail, that the all too noticeable wear on the engine would be accentuated by the unsatisfactory lubricating condition; the engine had to be kept running. Motor driven pumps were started to pump out a flooded mine, and a motor driven air compressor started at another development. With the load imposed on the engine and the conditions in the boiler room, three boilers had to be used to provide steam, and it was obvious that as the load increased four boilers would be required for this engine alone. With a large hoisting engine and air compressor both run by steam, still to be installed, the situation was a neat one for the management. Apparently all calculations had been made, and it was not possible that one engine require all the boilers. Since, by this time, I had found it useless to go into explanations, I pointed out that the engine was designed to operate on 150 psi at the throttle, and not 100 psi as was the case, and let it go at that.

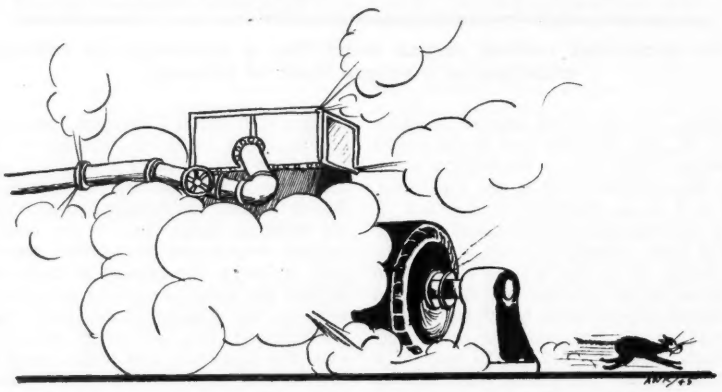
In providing new boiler water feedlines from the feedpumps, an extraordinary arrangement had been arrived at and piped up. Each boiler was provided with one 2-in. pipe entrance into it, and it was considered as acceptable, that two ways of feeding the boiler was provided, if two 2-in. lines were carried to a tee on the single 2-in. entrance pipe into the boiler shell. It also had been considered necessary to have two distinct 4-in. lines from the feedpumps along the fronts of the boilers. One of these lines taking care of four 2-in. lines into the 2-in. tees, on one side, and the other 4-in. line taking care of the four 2-in. branches into the other side of the tee. The discharge pipe from each pump was 2½-in., and each pump under normal conditions was capable of feeding four boilers. The pumps were single outside packed plunger type, with a steam end operated by a steam actuated valve of the Marsh design. These pumps had gone through the fire, but had supposedly been overhauled, re-installed, and connected up, ready to run.

When steam was turned on, neither pump would operate. The plungers and piston rods had been re-turned, to a smaller diameter, and packing fitted. The valves had been to an outside machine shop, rebored and new valves fitted. On examination I found nothing had been done about the steam cylinders and pistons, and these were in lamentable shape. It was not possible to retain the steam pressure in the hollow piston supplied through a tail pipe from the cylinder head, as this steam drove the valve back and forth when contact is made with a hole in the cylinder wall at either end of the stroke. Here again it was asserted that these pumps had run all right before and it was unreasonable that they would not run now. From other sources, however, this was denied and the evidence was finally conclusive enough that they had limped rather than ran properly. I pointed out that the cylinders should have been rebored, and new rings and pistons provided, or better still more reliable and up-to-date feedpumps provided.

In the meantime the boilers had to be fed by means of a 2-in. injector, which would not operate when tried out at first, although supposedly ready to operate. An examination of the injector, showed that parts from another injector had been used to make one complete injector. After some lathe work in refacing the inside seats, the injector was able to function.

After trying to have the steam cylinders of the two duplicate feedpumps sent out to a machine shop for reboring, etc., to which objections were raised as to whether the results would justify the expense and the length of time that would elapse before the finished job was returned, I rigged up a boring bar between the centers of a small lathe which had been procured after the fire. By stripping the carriage of this lathe, it was found that by setting the cylinder in one position on the carriage, the boring bar and head could just be centered. With some patience a fairly smooth job of boring was accomplished. The piston was built up by bronze welding, turned off to a running fit, grooves squared up, and rings that had been sent for, fitted to them. When the steam end was assembled on the pump, the pump started to run without any trouble. With a pressure gage on the water end, a test was made as to what pressure might be built up with the discharge valve closed. When the pressure had risen to 140 psi, water started to spray out between the base and the concrete block on which it sat. It turned out, that the square cast-iron base of the water end of the pump had been badly cracked in the recessed bottom. As a repair, a ⅜-in. thick steel plate had been cut and fitted to the square surrounding edge of the recessed bottom. With a heavy gasket this had been fastened on by 12⅝-in. capscrews. The area of the plate subjected to the pressure was about 170 sq. in. From the condition of the steam end and other evidence, it is doubtful if these pumps, when they operated at all, were able to put much water in the boilers, hence the idea of the large feedlines and arrangement described before. The plate was reinforced with angle iron welded to it, and with the addition of many more ⅝-in. capscrews a tight job was made.

It would serve little purpose to continue this painful narrative and recount the many other peculiar situations which would have confronted the master mechanic if he had stayed on the job. Life is too short for anyone to have to put up with such mismanagement. Sufficient has been told to show that besides the mere pro-



The engine was hardly visible through the clouds of steam

vision of safety in pressure vessels embodied in the present Boilers Act something more comprehensive is justified. An engineer, before he can secure a license, has to show by examination, that he has a comprehensive knowledge of power plant requirements, but in many cases where obvious dangers exist, he has no authority to act. He is, however, held responsible for accidents, if not directly, then indirectly.

Sealing Ground Water Off from Cable Bores

By Paul C. Ziemke

POWER CABLES that operate at fairly high potentials must be installed in permanently dry conduits for long continued trouble free service. For comparatively short runs the installation of standard galvanized conduit will serve the purpose well unless by chance the line should be laid in made ground that has a distinct tendency to cause corrosion by virtue of the many elements it contains. In other instances electrolytic action may be set up which may materially reduce the period of usefulness for the installation. Water, however, is the worst troublemaker and that is the subject we are particularly concerned with here.

In a mining property a well drill hole some 580 ft in depth was drilled to intersect an adit at which point a new substation was to be established. The lower 20 ft of the bore pierced some badly broken ground just above a water tight dike and this broken material was a heavy producer of water which had to be sealed before construction of the station could be started. Early attempts to seal the bore at the point of entry in the dike failed when 20 yards of dry concrete were poured down around the 4-in. casing in the hope that this material would lodge on the dike and set there. This experiment failed because the swiftly flowing water carried off all the finer ingredients of the mixture and only the coarse aggregate remained which, of course, did not retard the water.

The use of Bentonite suggested itself and arrangements were made to pump this material in place. Bentonite has the admirable qualities that when it injected into formations, in solution with water, it will penetrate through the most minute fissures and when once in place swells into a gel that effectively seals off all water. Three oil drums and a small steam pump were installed at the bore. The barrels were so arranged that the mixture stream could be directed into the bore or into one of the barrels at the discretion of the operator. This setup permitted thorough mixing of the batch before sending it down the outside of the casing by circulating it through the pump several times. A ½-in. line was extended down the outside of the casing to the dike formation and was used to conduct the mixture from the pump. One barrel was used to mix the batch roughly by hand, the second was being pumped out in the meantime, and the third one was used as a water reservoir. As an experiment the initial batch was made up of 8 lb of Volclay to 40 gal of water but it was soon learned that this mix was too lean and the next attempt used 15 lb of Volclay to 40 gal of water. One bag of Volclay was pumped down into the broken rock above the dike and then operations were halted for two shifts to permit the gel to expand to the limit and to become set. The flow of water could be seen to lessen by the hour and after the two day lay-off, had ceased to run entirely. The next step was to pump out the water above the seal and when this was completed the work of forcing in additional grouting was resumed.

This operation required an additional 8 bags of Volclay before the gelatinous mass rose to the top of the bore. At that point operations were halted for the rest of the shift and evening to permit the mass to settle. On inspection the next day the level had receded some 15 ft and additional material was added to bring the mass up to the ground level. At this time it was decided to cap off the space between the conduit and the edge of the bore with concrete so that extra hydraulic pressure could be brought into use and the more thorough penetration of the rock strata would be assured. The pressure indicated was 100 lb and the pumping was kept up to the point of refusal. A total of 18 bags of material was used, 4 of which were 4 mesh, and 14 were KWK-33.

A NEW MINIATURE permanent magnet type of oscillograph has been developed by the General Electric Co. for use in a wide variety of recording applications where space and weight are at a premium. This oscillograph fills the need for an instrument on projects where it would be impossible to use the larger and heavier type of instruments. The essential elements of a recording magnetic oscillograph are provided in this simple, compact and sturdily designed unit having overall dimensions of 4½ in. by 4½ in. by 14 in. and a total weight of 10 lb.

"Whoopee, number three wins! That's four beers ya' owe me—start her up again, Gus!"

The Boiler Fireman's Handbook

By J. R. DARNELL

Inclined rocking bars—Overfeed Types . . . Use of low-volatile coals . . . Importance of proper adjustment of Hopper Gate Opening . . . Operation of Front Overfeed Type . . . Banking the Fire on an Overfeed Stoker . . . General Pointers on Operation

Part XIV—Stoker Firing Methods (Cont'd)

IN CHAPTER XII we presented an outline of the two main divisions and their respective sub-divisions for various types of stokers. In the first sub-division of the overfeed type we discussed forced and natural draft chain grate stokers which were classed as having horizontal moving bars. We now come to the second sub-division of the overfeed type—inclined rocking bars. These may be either hand or power operated. Fig. 1 shows a hand operated type used for small plants under 500 hp.

In the power operated types there are two general classes depending on whether the coal is fed from the front or sides.

Inclined front-feed stokers receive coal from a hopper extending across the entire front of the furnace, the discharge from the hopper being upon an inclined coking plate from which it is pushed by oscillating plates, or slides by gravity to a series of rocking or oscillating grate bars extending across the furnace. At the lower end of the grate are dumping plates which hold the unburned coke until combustion is completed and also the ash accumulation between times of cleaning the fire. In most installations an ignition arch is provided for the front part of the stoker, of either the suspended or sprung type, the suspended type being more common.

Coal fed upon the coking plate has the heat of the furnace reflected down upon it by the ignition arch, thus driving off the volatile matter and igniting the coke. The inclination of the grate is usually about 45 deg., which is sufficient, with the aid of the grate-bar movement, to cause the fuel to descend. At the same time, the working of the grate breaks up the cakes of coke, provides air spaces through the fuel bed and sifts the ash to the space below. By the time it reaches the dump plates, the fuel bed consists of coarse ash, clinker and some unburned coke.

Use of Low-Volatile Coking Coals

These stokers are adapted to low-volatile coking bituminous coals such as found in the eastern states, which require agitation of the fuel bed and are not particularly difficult to ignite. Forced draft has been used successfully with the inclined front-feed stoker but, if the fuel bed is more than 6 in. thick, the grates will not agitate it sufficiently for good combustion. When used with natural or induced draft, these stokers are unsuited to conditions where the load fluctuates rapidly from one extreme to the other. The maximum rate of combustion is about 35 lb of coal per-hr per-sq-ft of grate surface, with draft over the fire at about 0.5 in. of water.

Side-feed stokers differ little in the principle of operation from the front-feed type. Use is made of two inclined grate surfaces, which face each other so as to form a furnace of V cross-section, the bars running parallel with the fuel bed. Coal hoppers are placed along the full length of each side of the furnace, which is always of the extended front type with an arch covering the entire space over the grates.

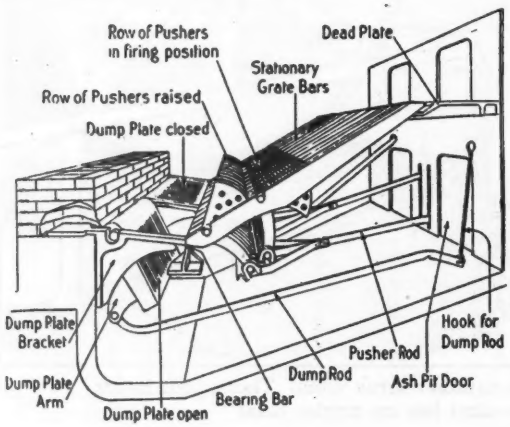


Fig. 1. This shows the essential parts of a hand-operated, overfeed type of stoker

Adjusting of the Hopper Gate Opening Is Important

In operation of both of these types of over-feed stokers, the greatest difficulty is to adjust the hopper gate openings and the motion of the grate bars so that the proper combustion rate is secured, yet no holes develop in the fuel bed. These stokers are also likely to sift considerable fine unburned fuel through the grate during the early stages of combustion. With proper arrangement of the ash pit, these siftings are not lost, as they can be refired without much difficulty; but, if too much of the partly burned coal is put into the hopper at a time, furnace conditions are likely to be upset, resulting in a temporary reduction in efficiency.

Operation of Front Overfeed Type

In Fig. 2 is shown a view of a stoker of this type, Coal is fed from the stoker hopper by a pusher plate, which is mechanically operated, then passes over a dead plate which is given the same general slope as the grate hopper.

In starting the fire, the grate bars are first covered with wood, to prevent the coal from running from the hopper to the ash pit. The hopper full of coal is then fed in and ignited by throwing in a small amount of wood or oily waste, gradually feeding coal. In the absence of steam, this can be done by hand operation of the coal-feeding pusher, until the entire grate surface is covered with ignited fuel.

With this stoker, a fuel bed about 7 in. thick is maintained at the dead plate, tapering down to about 4 in. at the guards. This thickness varies, of course, with different coals and rate of combustion.

Draft regulation for the proper combustion rate should always be accomplished through adjustment of the boiler damper. Regulating the intensity of the fire by the use of the ash pit doors is not good practice, as it shuts off almost entirely the air supply through the fuel bed, with consequent smoke emission. The grate bars also become overheated and an increase of draft is produced through the boiler settings proper, causing considerable air to be drawn in through doors and cracks in the setting. Generally a differential gage indication of 1 to 1½ in. suction is satisfactory.

In the V type of over-feed stoker, coal is stored in side hoppers from which it feeds by gravity to the sloping grates. The fuel bed moves downward toward the center of the furnace, where the ash and clinkers are discharged through a clinker grinder which is mechanically operated, as are also the vibrating grates. The arch over the furnace may be of

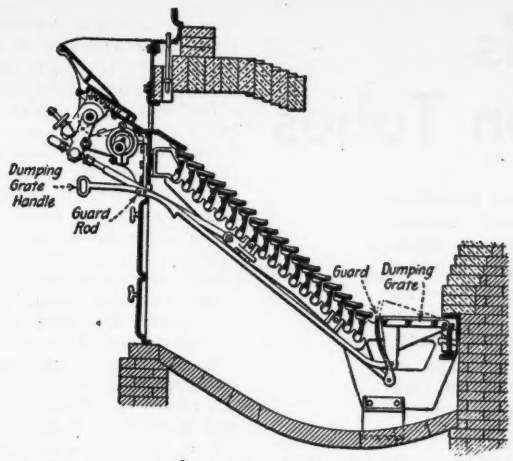


Fig. 2. This is a typical example of a front-overfeed stoker with coal fed by a pusher plate

either the suspended type or the air-cooled, sprung type. A typical example of a stoker of this type is shown in Fig. 3.

Operating methods for this stoker are somewhat similar to those outlined for the front-feed type, although the thickness of the fire is somewhat less. A fuel bed 3 or 4 in. thick is recommended, although this varies depending on the coal, draft and load.

To slice and break up the fires, in case of a sudden demand for steam, a slice bar is inserted through the capped roust holes on each side of the stoker. Push the slice bar in flat, along the grate and then draw it out on edge. Never roust the fire at the upper end of the grate.

Banking the Fire on an Overfeed Stoker

If it is desired to bank the fire, all the clinkers should be removed and the coal pulled to the front end of the grates. Fine coal is thrown through the fire door, covering the live coke; the doors on the front of the stoker are then closed and the breeching damper is nearly closed. To start up from a banked fire, the coke should be spread along the bottom of the grate and the grates covered with coal from the magazines.

General Pointers on Stoker Operation

If you have never had specific instruction in the operation of a certain make of stoker and there is no one around to give you accurate information, don't trust entirely to books but write to the manufacturer. Co-operate with him. He will be glad to help you.

Order your spare parts from him—don't try to make them yourself. Keep a reserve stock on hand at all times. All manufacturers have a Spare Parts Catalog. If you haven't one, send for it at once. Constant inspection and replacement of worn parts will greatly prolong the life of a stoker.

Stokers need lubrication as much as any high grade machine. Use only the kind of oil or grease recommended by the manufacturer.

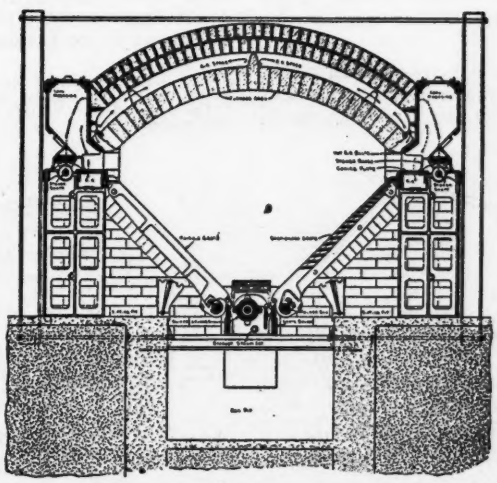


Fig. 3. In the side-overfeed stoker the green coal works downward from the sides toward the center

SHORTS

A NEW TIMING and control motor with terminal shaft speed of 1 revolution per hour is designed to meet control manufacturers post-war demands for a slow speed, totally enclosed motor for use in timers, thermostats, oil burners and coal stoker controls and other apparatus where a minimum of space is available. The new motor has an input rating of 2 watts and can be furnished in other speeds up to and including 6 revolutions per hour.

* * *

THE firefly is a much more efficient producer of light than our best tungsten filament lamps. It is roughly estimated that 90 per cent of the radiant emission from a firefly is luminous, closely approaching 500 lumens per watt. This is ten times the ultimate efficiency that could be expected from a tungsten filament lamp, since tungsten when melting at about 3655 deg K can generate visible light at no better than 55 lumens per watt. If such a lamp were to burn for several hours an efficiency of 35 lumens per watt would more correctly represent a top practical limit. In ordinary commercial practice, tungsten lamps only develop about 15 lumens per watt.

Fluorescent lamps now develop some 45 to 60 lumens per watt and are capable of doing roughly twice as well.

* * *

GREASES deteriorate in service primarily because of (a) breakdown of the grease structure, (b) absorption of water, and (c) change in composition resulting from oil evaporation and from oxidation. Investigations at the Bureau of Standards on working of greases have shown that they differ markedly as regards the rate of breakdown of the grease structures dependent upon the characteristics of the oil and soap used in their manufacture, but particularly upon the percentage of soap used. No grease has been tested thus far that does not continue to break down with increased working. However, it has been found possible to produce greases in which this breakdown takes place so slowly that it is not serious. This is true of very few commercial greases. Greases have been found to differ greatly as regards the effect of water, depending upon the nature of the soap used in their manufacture. New test methods have been developed for water resistance of greases and also for loss of oil by evaporation at high temperatures. These conclusions—the results of an intensified study of greases for military needs—have led to renewed activity on the part of manufacturers. This can hardly fail to result in marked improvement in the greases available for civilian use.

The Fundamentals of Electron Tubes

Part II Vacuum tubes . . . Thermionic emission . . . Electron emission from a solid conductor . . . Effect of a vacuum on thermionic emission . . . The electron tube or valve . . . The vacuum diode . . . The Edison effect . . . The Fleming valve . . . Direction of electron flow . . . Electron emission from different materials . . . The principle of the heater type of emitter . . . Relation of anode voltage and cathode temperature upon the anode current

By Ralph B. Immel

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THE FUNDAMENTAL principles of the electron theory of matter and the theory of electric conduction were presented briefly in the preceding article. Now, we will consider the principles of thermionic emission and its application in the electron tube.

The thermionic emission or process by which electrons can be emitted from the surface of heated solid substances is analogous to the evaporation of a vapor from the surface of a liquid.

As shown by Fig. 3, when an electric current flows through a resistance wire, such as tungsten, electrons will be emitted if the wire temperature is raised to approximately 2400° Kelvin. The Kelvin or absolute temperature is equal to the centigrade temperature in degrees plus 273 degrees. The heat in watts generated in this conductor is equal to the current in amperes squared times its resistance in ohms. The number of electrons emitted is dependent only on the nature of the material and the temperature or wattage dissipated in the conductor. The same number of electrons will be emitted from a given material by a definite unit of heat energy regardless of whether the heat is generated directly by passing alternating or direct current through the material. The same result is obtained by indirect heating, since the electron emission depends only on temperature.

Electron Emission from a Conductor in a Vacuum

The emission of electrons from the conductor shown by Fig. 3, requires that the wire temperature must generally be high. In an atmosphere of air the wire will probably burn up or oxidize very severely at this temperature. The oxidation can be minimized and the operating life increased very effectively by inserting the resistance wire in an evacuated glass or metal shell as shown by Fig. 4. In a evacuated glass shell or globe, the resistance wire is known as a *filament*. While the filament emits electrons it is not usually classified as an electronic device as it is nothing more than the very familiar incandescent lamp.

Electron Tube or Valve—Vacuum Diode

While the filament of a lamp bulb may emit electrons, it is not considered an orthodox electronic device as the electron emission or effect cannot be utilized. Its main use and value is as a source of light or heat.

In 1883 while experimenting with his newly invented incandescent lamp, Edison discovered that a small current of electricity would flow from a heated filament to another electrode placed inside the bulb. This phenomena is known as the Edison effect. When a positive potential was applied to the additional electrode which is now known as the anode (or plate[1]) an electron flow from the filament to the anode would occur as shown by Fig. 5. When a negative potential was applied to the anode, the current flow from the filament to the anode was negligible or zero as shown by Fig. 6. The electrostatic field emanating from the negatively charged anode repels the electrons and prevents current flow.

Many years later, the Edison effect was explained and Fleming, in England, utilized the phenomena for a vacuum valve. As this device will allow current to flow between the filament and anode only when the anode is positive and will not allow the current to flow when the anode is at a negative potential, it is a perfect rectifier. It was first used as a detector for rectifying high frequency radio currents in order to secure a direct current which would produce an audible sound in the ear phones of a radio receiver. This electronic rectifying tube was then known as a Fleming valve. It is now known as a *two element* (filament and anode) or a *diode* (two electrode) vacuum tube. It is also known commercially as a Kenotron.

It should be noted from the previous discussion that in an electron tube that the current flow is composed of a stream of electrons or negatively charged minute particles which flow from a negative filament to an anode which is of higher potential than the filament. *The electrons flow from negative to positive points of potential.* This conception is contrary to the customary assump-

[1]Although plate and anode mean the same, plate is usually associated with radio practice and anode with industrial electronics.

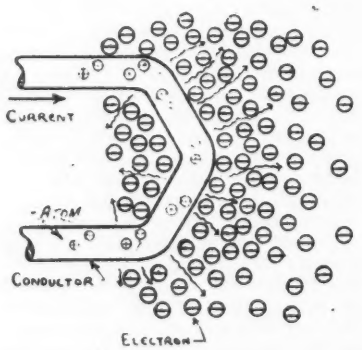

Fig. 3. Principle of thermionic emission

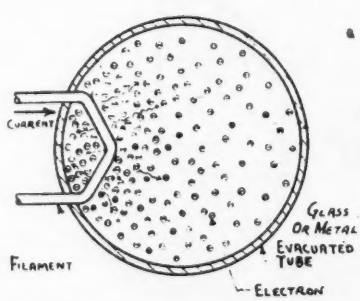

Fig. 4. Thermionic emission in a vacuum tube

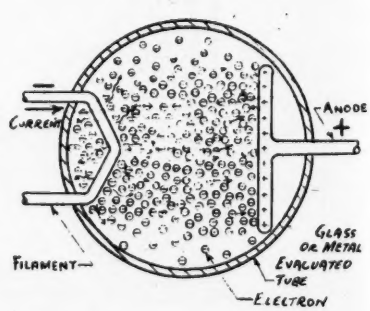

Fig. 5. The two electrode vacuum tube with a positive charge on the anode

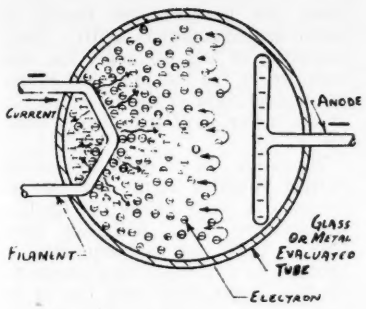

Fig. 6. The two electron vacuum tube with a negative charge on the anode

tion that the current flow is from a positive to a point of negative potential. This difference in viewpoint exists as use was made of electricity long before the electron theory came into existence or before the electronic nature was thoroughly understood. The assumption that the current flow is from positive to negative points of potential for the analysis of many electrical devices and circuits is of little consequence as long as the same system and notation is consistently applied. However, when electron flow is considered, there should be no doubt as to the direction of flow. In order to understand and apply electronic tubes, it is very important and essential to consider electron flow as from negative to positive points of potential.

It has been found that while a tungsten filament can be operated at a very high temperature to emit a given number of electrons, some other materials can emit the same number of electrons with a lower temperature. Barium, calcium, thorium, and strontium oxides are materials which are good electron emitters. The physical properties of these materials are unsuitable for directly forming them into a filament; therefore, a thin application of these oxides to a high resistance filament will increase the electron emission from that filament for a given temperature when compared to the emission from an uncoated filament. However, as it is quite expensive to commercially apply these oxide coatings to a filament, the coating is usually applied to a metallic surface or a cylinder known as the *cathode*. The cathode usually surrounds or is in close proximity to the filament which supplies the heat energy for electron emission from the cathode, as shown by Fig. 7. The heating element in this type of tube is known as a *heater* rather than a filament.

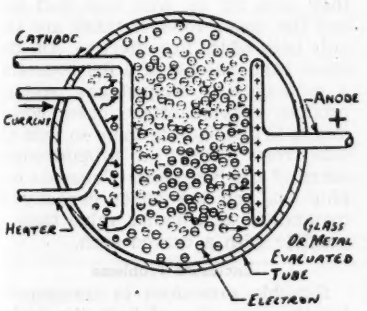

Fig. 7. Illustrating the principle of the indirectly heated cathode

The heater for this type of tube does not necessarily have to emit electrons and is usually operated at a temperature lower than that required for efficient electron emission. It is only necessary for the heater to raise the temperature of the cathode material to an efficient temperature for electron emission. This type of tube is advantageous for many applications over the filament type, as the heater may be operated at a lower temperature for the same electron emission from the coated cathode. Lower heater temperature results in a longer heating element life. Another advantage to this type of tube is that there is no electrical connection between the heater and the cathode. When several heater type tubes are used in an electronic device, all the heaters may be energized from a common transformer or power supply since the heater and cathode are electrically isolated within limits.

At low filament or cathode temperatures the electron emission is very low. An increase in temperature will cause more electrons to be boiled out of the cathode. From a filament temperature of O to T_1, the electron current is limited by the cathode emission as shown on Fig. 8. At a filament, or cathode temperature T_1, the electron emission and anode current increase very rapidly. However, at temperature point T_2 an increase in cathode temperature does not cause a very effective increase in anode current. According to the formula for electron emission, the emission current should increase indefitely with an increase in temperature. As the transit time of an electron to travel from the filament or cathode to the anode is a finite time, and are

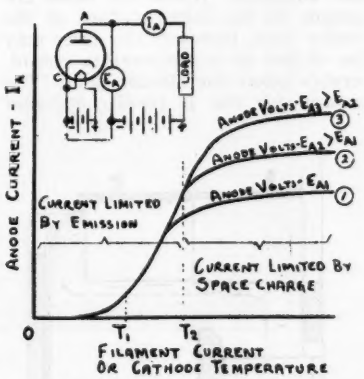

Fig. 8. Curves showing the plate current cathode temperature characteristics

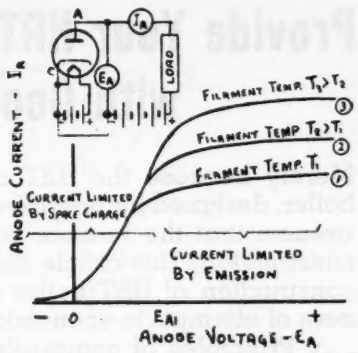

Fig. 9. Curves showing the plate current plate voltage characteristics

always a number of electrons in the space between the electrodes. With an increase in temperature the number of electrons in this space will increase until their total negative charge neutralizes the effect of the positively charged anode. Any additional electrons that may be emitted will be repelled by the space charge created by the electrons in the space between the electrodes and will be forced back into the filament or cathode. The number of electrons cannot increase regardless of the temperature under these conditions. This saturation effect is caused by an electrostatic field known as *space charge*. Space charge results in a cloud of electrons of increasing density from the anode to the cathode. The anode current can be increased for a given temperature by increasing the anode voltage as indicated by curves 2 and 3 (Fig. 8). For an increased anode voltage, the number of electrons that may accumulate in the space between the electrodes will increase until the effect of the anode voltage is again neutralized.

Fig. 9 shows the effect of a change in anode voltage upon the anode current when the filament or cathode is operated at a constant temperature. As the electrons acquire an initial velocity when they leave the cathode, some electrons may reach the anode even when the anode potential is zero. The anode must be charged at a negative potential to completely stop the flow of anode current. From a negative anode potential to a potential EA_1 the anode voltage is so low that the anode current is limited by the space charge. However, at an anode voltage exceeding EA_1 practically all the electrons emitted by the filament are attached to the anode. Any further increase in anode voltage will not increase the anode current. This effect is known as *filament* or *cathode saturation* as the electron emission limits the current flow in the tube. For a given anode voltage the anode current can be increased only by increasing the electron emitting element temperature as shown by curves 2 and 3 (Fig. 9).

(To be continued)

Provide Your HRT Boilers with Good Furnace Settings

Merely because the HRT boiler is a relatively low cost boiler, designed for operating at low steam pressures, don't assume that the furnace can be of the cheapest type of construction. This article discusses the proper design and construction of HRT boiler settings . . . The shortsightedness of attempts to economize by the use of cheap settings . . . Principles of combustion as they affect furnace design . . . Necessity for expansion in furnace walls . . . Importance of foundations . . . Why solid walls fail and why sectionally supported furnace type of wall has advantages

By GEORGE P. REINTJES

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Kansas City, Mo.

THE HORIZONTAL RETURN TUBULAR BOILER—unheralded and unsung hero of the small heating and power plant has, due to its relatively small steaming capacity, been relegated to the unhappy position of orphan in the boiler world. This is indeed unfortunate, since the number of boilers of this type is great and the service performed by them noteworthy.

Since the HRT boiler is a relatively low cost boiler designed for operation at the low steam pressures employed for heating purposes, and for low-pressure requirements, the idea that every part of the installation should be the cheapest possible construction has gained such momentum that cheapness has become a cardinal law in the minds of many charged with the installation and operation of this type boiler. This is indeed, unfortunate; unfortunate because often the cheapest initial construction is the most costly of luxuries when due consideration is given to maintenance and operating efficiency.

A case in point is the construction of the heat enclosure or furnace provided with the HRT boiler. Too seldom has much consideration been given to the use of the better types of heat enclosures, and the reason is obvious. The initial cost of a good furnace setting is often twice as much as the cost of the boiler. This high cost is due to the fact that the HRT boiler requires from 3 to 4 sq ft of wall per boiler hp while the water-tube boiler will only need about one-half as much wall area per boiler hp. At the outset, therefore, the furnace is much larger for an HRT boiler than it is for a water-tube boiler of comparable horsepower rating.

A suitable furnace for any boiler, regardless of type, must fulfill certain requirements dictated by the laws of proper fuel combustion. It must have adequate volume to insure that all of the fuel is burned. As the volatiles are driven off from the coal being burned, they must be kept at a sufficient temperature to maintain combustion. While the ignition temperature for the volatiles from coal as well as gas and oil fuels ranges from 1000 to 1200 F, actually it is advisable to maintain the temperature in the furnace at a value well above this range to insure firing. It is generally considered that the lower furnace temperature limit is 1500 F, although temperatures above this value are advisable. Where the flame impinges on the lower surface of the boiler shell, however, the gases may be chilled to a temperature considerably below the ignition point. The reason for this is readily apparent when the temperatures inside the boiler are considered. With a boiler operating at 100 psi gage, the temperature of the steam is 338 F, and the temperature of the lower portion of the boiler shell is probably under 350 F.

Whenever the temperature of unburned volatiles in the fuel are reduced to a value below the kindling temperature, they will not burn. Unless they can subsequently be brought to a temperature above the kindling point, they pass out of the boiler in an unburned state and the heat which they would have produced

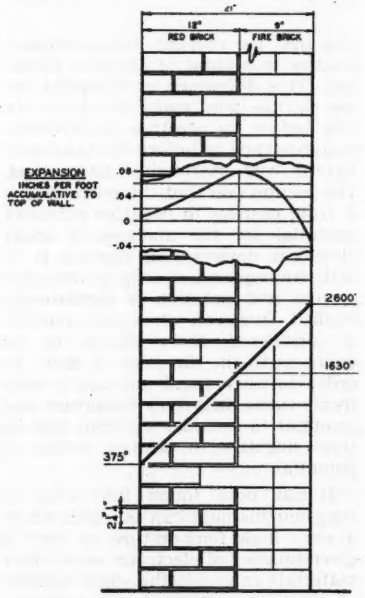

Fig. 1. Temperature gradient and expansion of solid walls

is lost. As a result, it is necessary to design the furnace in such a manner that the flame does not touch the boiler shell.

Another important feature in the construction of a suitable heat enclosure is the correct shape for the arch at the rear of the boiler, Fig. 2. Where a curved arch is used, the tendency is to deflect the hot gases away from the lower row of tubes. This results in such low gas velocities through the lower tube rows that they soon fill up with soot and ash and the upper rows of tubes are the only ones which are effective. On the other hand, the use of a flat arch and a rectangularly shaped gas passage produce eddying of the gases which assists in distributing them so that all tube rows receive a proportionate share of the hot gases. Tubes do not plug up, and the boiler capacity is maintained at a higher value than is possible with a curved arch.

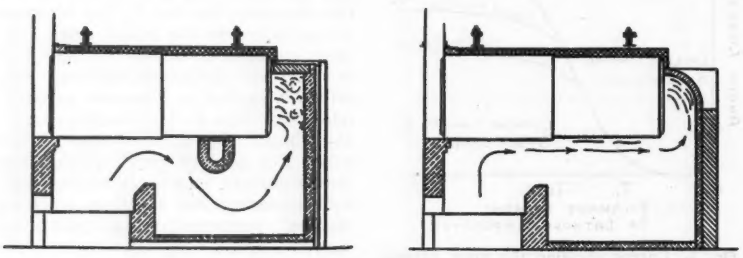

Fig. 2. Two types of rear arch construction

Enclosure Problems

Suitable provisions to compensate for the expansion of both the boiler shell and the furnace refractories must be incorporated in the heat en-

closure to ensure trouble-free operation. For example, the boiler shell may expand from ¾-in. to 1¼-in. in length and from ⅜-in. to ⅝-in. in diameter depending upon the dimensions of the shell and the temperature rise to which it is subjected. The expansion of the refractories in the walls will vary considerably due to the wide range in temperature to which the various portions of the setting are subjected, being as great as ⅛-in. per foot in some instances.

The fabrication of a satisfactory heat enclosure operating under the conditions just outlined involves many problems which cannot be adequately met by the use of the lowest-cost heat enclosure. The enclosure must be designed to absorb the expansion of the boiler shell without damage to it or the formation of cracks which produce excessive air leakage into the furnace and consequently lowered boiler efficiency. Another complication is introduced due to the fact that the upper half of the boiler shell projects above the enclosure. Added to these is the problem of horizontal expansion in the enclosure which must be relatively long for a given boiler capacity. For example, the outside length of the setting for a 150 hp boiler may be as much as 27 to 28 ft.

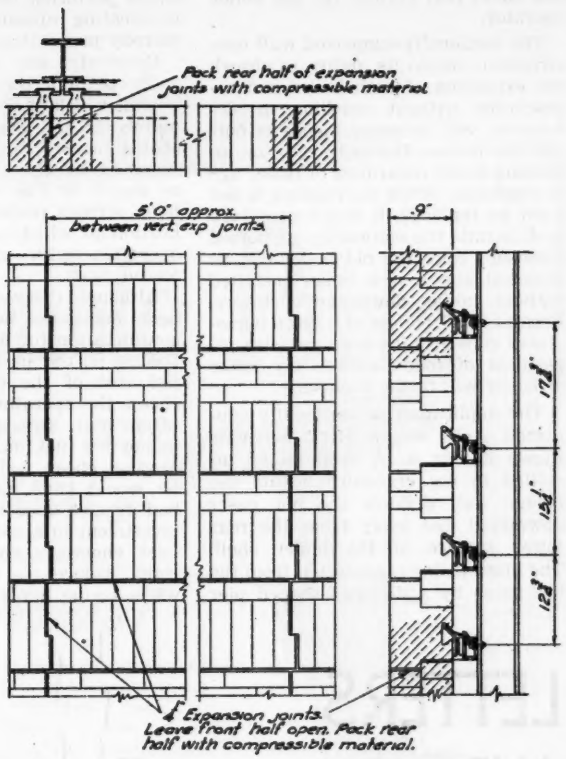
Pack rear half of expansion joints with compressible material
5'0" approx. between vert exp joints
9"
17'
12'
12'
Expansion joints. Leave front half open. Pack rear half with compressible material.

Fig. 3. Reintjes sectionally-supported construction showing method of support and expansion joints used

Foundations

Many boiler setting failures, particularly when solid walls are employed, have been attributed to the disintegration of the foundation resulting from the drying out and subsequent shrinkage of the soil beneath. Heat penetration through the uncooled floor of a furnace has been known to dry out the soil for a depth of 15 ft below it. This heat penetration and subsequent soil drying can be prevented by the use of an air-cooled furnace floor.

The solid masonry setting should be equipped with adequate buckstays. In some instances the buckstays provided are inadequate; in others they have been omitted entirely since there was insufficient space for their installation in the area available for the boiler. Where the available boiler space is limited, the boiler columns are generally encased in the solid walls. When this is done, oxidation and corrosion of the columns invariably follows and eventually the columns are corroded to such an extent that they fail to support the weight of the boiler.

Solid masonry walls have failed to give satisfactory service in many instances. On the other hand, the sectionally-supported construction, Fig. 3, due to its inherently superior performance, will reduce maintenance costs, maintain boiler efficiency, and prolong the life of the enclosure. In spite of its higher initial cost, the sectionally-supported heat enclosure

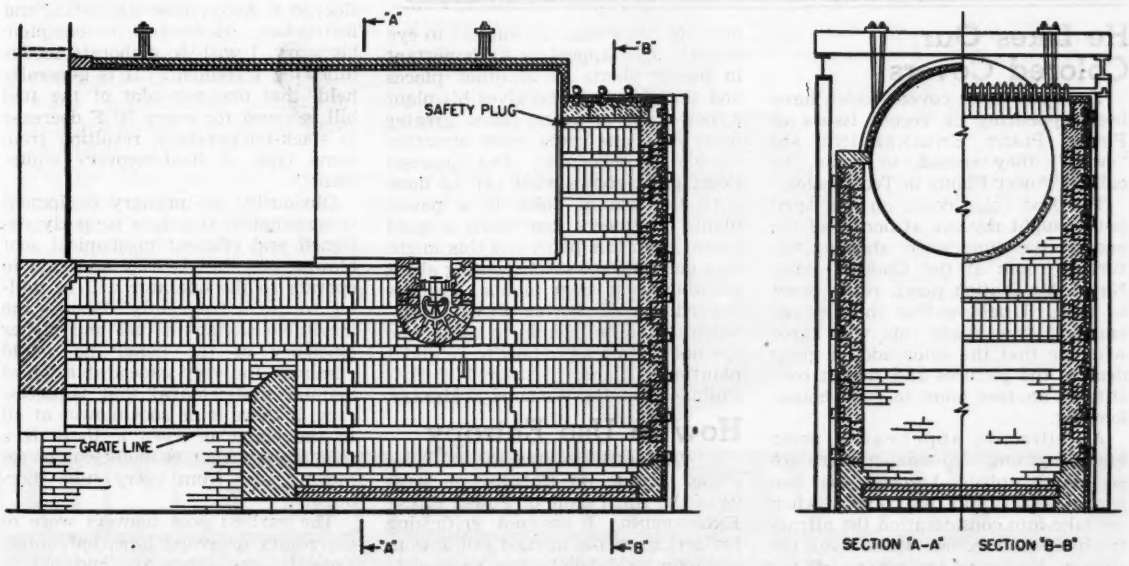

Fig. 4. Reintjes sectionally-supported construction applied to HRT boiler

can effect real savings for the boiler operator.

The sectionally-supported wall construction, due to its ability to absorb the expansion of both boiler and refractories without cracking or deforming, will in many instances outlast the boiler. It can be used on an existing boiler regardless of boiler age or condition. When the existing boiler must be replaced, it is not necessary to dismantle the sectionally supported enclosure since the old boiler can be removed and a new boiler installed without taking down the enclosure. Because HRT boilers of a given horsepower capacity are the same size regardless of manufacture, any make of boiler will fit the enclosure.

The application of sectionally supported walls to an HRT boiler is shown in Fig. 4. A drop nosing installed in the enclosure behind the bridge wall deflects the hot gases downward and away from the rear lower surface of the boiler shell. The blowoff line is protected from the hot gases by a diamond-shaped pier which performs the further function of creating turbulence in the gases thereby preventing stratification.

Generally the use of supported walls permits the reduction of the overall width of the furnace approximately 18 in. Furthermore, an air-cooled furnace bottom can be easily installed by the use of hollow tile, as shown in Fig. 4. This air-cooled floor permits preheating of the combustion air which can be arranged for operation with either natural or forced draft.

Although the sectionally-supported heat enclosure has received scant consideration for application to HRT boilers in the past because the initial cost of the enclosure was not cheap, the operator of the boiler has often been forced to spend more money for fuel, maintenance, and the original cheap wall installation than he would have had to spend if he had insisted upon the more expensive investment in a sectionally supported heat enclosure which would materially reduce his maintenance costs while saving him fuel.

LETTERS AND COMMENTS

He Likes Our Colored Covers

THE FOUR-COLOR covers which have been appearing on recent issues of POWER PLANT ENGINEERING are "swell"; they should, or could, be called "Power Plants in Technicolor."

The first color cover on the April issue caught my eye at once and the one on the June issue, showing the turbine room at the Quonset Point Naval Air Station plant, really went to town. I believe that the average engineer who reads this will agree with me that the color adds a great deal to the pictures and that it constitutes another point in good housekeeping.

An attractive appearance never hurts anything. No wonder there are so many wolves—I mean the two legged variety—in this country when we take into consideration the attractively dressed women which roam the streets. Perhaps I am getting off the subject but I feel that all of us, engineers or otherwise, are subject to eye appeal. Eye appeal is as important in power plants as in other places and the engineer who gives his plant a new coat of paint takes greater pride in it and gives more attention to his housekeeping. The Quonset Point plant shows what can be done with the use of color in a power plant. Engineers can learn a good lesson from this plant and this might be a good time to start thinking about painting their own plants. Perhaps the editors of POWER PLANT ENGINEERING can be of help to those who are not certain as to how to go about painting a plant.

Philadelphia, Pa. WILLIAM T. MULLEN

How to Use Entropy

I WAS QUITE interested in Tyler Hicks' article on Entropy on page 94 of the April issue of POWER PLANT ENGINEERING. I am not criticizing his article or his method but I wonder why he did not show us how to use entropy in solving his problem on the Rankine cycle. If Mr. Hicks will pardon my presumption I will endeavor to show the formula as I learned it.

First, we have to find the final quality, $x_1n_1 + \theta_1 - \theta_2 \div n_2 = x_2$ or $0.985 \times 1.0556 + 0.5138 - 0.1326 \div 1.8456 = 0.769$ which is the final quality.

In the above, x_1 = Initial quality; n_1 = Entropy of vapor or 150 psi, Abs.

θ_1 = Entropy of saturated liquid, at 150 psi, Abs.

θ_2 = Entropy of saturated liquid, at 1 psi, Abs.

n_2 = Entropy, evaporation at 1 psi, Abs.

$x_1 r_1 + q_1 - (x_2 r_2 + q_1)$ or $0.985\% \times 863.6 + 330.51 - (0.769 \times 1036.3 + 69.7) = 314.54$ where x_1 = Initial quality; r_1 = Enthalpy, evaporation, 150 psi, Abs;

q_1 = Enthalpy, liquid, 150 psi, Abs;

x_2 = Final quality;

r_2 = Enthalpy, evaporation, 1 psi; Abs;

q_2 = Enthalpy, saturated liquid, 1 psi, Abs.

$1194.1 - 69.7 = 1124.4$

$314.5 \div 1124.4 = 28.6\%$ Efficiency.

The values in these calculations are taken from the latest steam tables which may not be identical with the tables found in text books but I used symbols which are more commonly used and more readily recognized. Speed the day when all steam tables will be the same—when there is no longer such a variety.

Seattle, Wash. NELSON W. DUELL

Soot Blowers for HRT Boilers

THOSE, who either for practical reasons or because of personal preference favor HRT boilers, will find the above article in the May issue by George A. Aiken most interesting and instructive. However, to complete his story, I wish to elaborate on his following statement: "It is generally held, that one per cent of the fuel bill is saved for every 30 F decrease in stack-temperature, resulting from some type of heat-recovery equipment."

Obviously, the primary equipment to accomplish this is a properly designed and efficient mechanical soot blower, one that is easy and safe to operate so the operator will be willing to use it frequently. Besides the inevitable saving in fuel and higher efficiency of the boiler he would eliminate the very undesirable job of manual soot-removal that is necessary, if there is no soot blower at all to the boiler or even if there is a soot blower, that is inefficient in removing soot from every tube thoroughly.

The earliest soot blowers were of the rotary or swing type, but unfortunately, the tubes are laid out in horizontal and vertical lines, but not

Interchangeable Parts

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Fig. 1021
150 lb. S. P.
Iron Body
"FERRENEWO"
Regular Type

All parts of the valves shown here (except bodies and bonnet rings) fit each other perfectly. If, for example, you need a stem, disc, or seat ring for the "Renewo", you can use the corresponding part of the "Ferrenewo" —*it is exactly the same.* This means fewer parts to be carried, speedier repairs, and greater ease in making them.

Fig. 73-P
200 lb. S. P.
Bronze
"RENEWO"
Plug Type

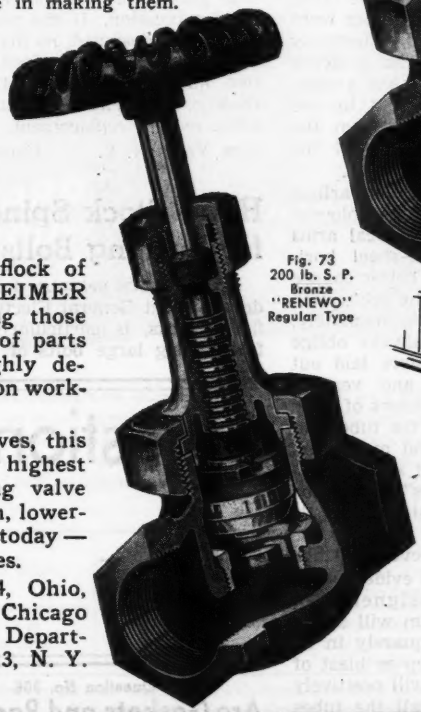

Fig. 73
200 lb. S. P.
Bronze
"RENEWO"
Regular Type

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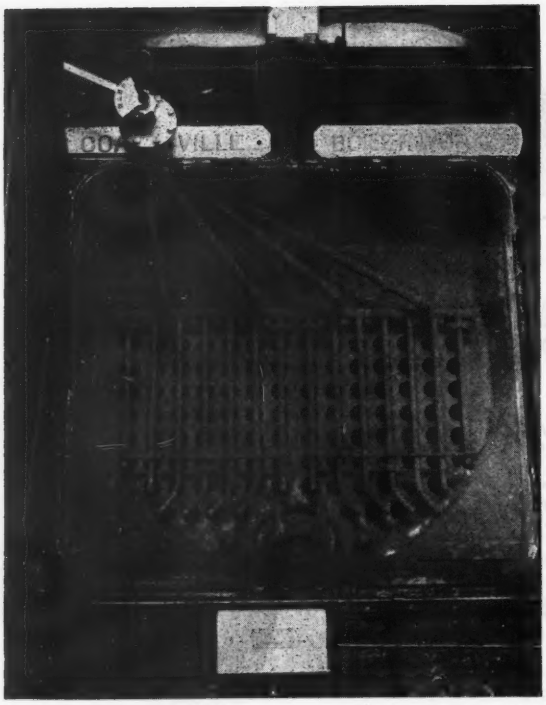


Fig. 1. A fixed-nozzle type of soot blower installed on an HRT boiler

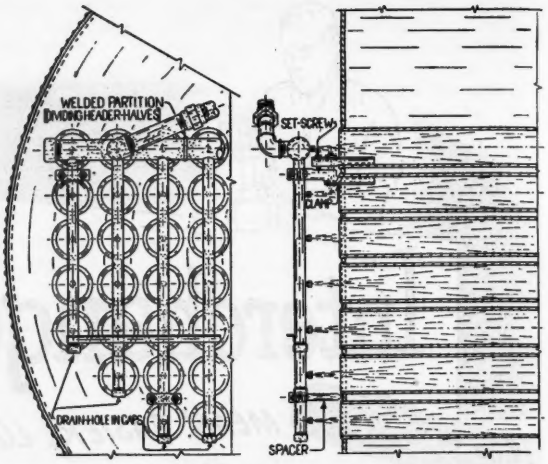


Fig. 2. Showing arrangement of soot blowers in front of tubes

in concentric circles. It was a case of trying to square the circle or vice versa, which just could not be done, so that only some of the tubes were blown squarely and effectively through their center. The evidence of this can be found on many a tube-sheet, that show circles cut by the jets of steam, that issue from the nozzles in the rotating arm of the soot blower.

An improvement over this earliest type was the straight-line soot blower, which has one or two vertical arms moving across the tube-sheet horizontally and thus has a better chance to reach the center of the tubes with the jets of steam. Unfortunately, boiler-maker will not always oblige by having the tube-centers laid out exactly in horizontal and vertical lines, but instead for reasons of their own will have some of the tubes out of line, especially around man-holes. The consequence is, that such "irregular tubes or "stragglers" will not be reached by the jets of steam at their center and thus will have to be cleaned manually whenever possible.

From this it becomes evident, that with the properly designed soot blower the jets of steam will strike each and every tube squarely in its center, so that the sweep or blast of steam at high velocity will positively remove the soot from all the tubes end to end. This leads to the logical design of the fixed-nozzle type soot blower, that is shown in Fig. 1.

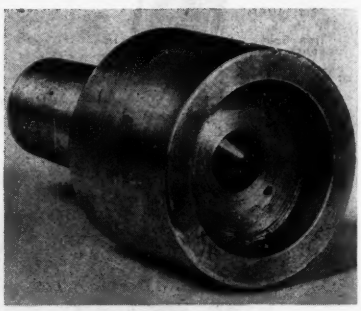
It should be noted, that there is a four-way disk-valve located above the boiler-door, so that only one of the four feed-lines is supplied with steam or with air if the steam-pressure is too low. Each feed-line in turn supplies steam or air to the individual nozzles, facing about one fourth of the total number of tubes at a given time, so that the four positions in the four-way valve will take care of the four groups of nozzles or tubes in rapid succession. If this soot blower is properly designed, no manual soot-removal should be required. Still the two halves of the pipe-frame are readily removable, should boiler-tubes require replacement.

New York, N. Y. EUGENE HAHN

Head Stock Spindle for Turning Bolts

A HEAD STOCK SPINDLE, designed and developed at General Electric's Pittsfield Works, is particularly suitable for turning large bolts of the body-bound type. Through its use, both in and out of the lathe, handling time has been reduced 50 per cent.

Both ends of the bolts are centered, and when they are placed in the lathe a drive force is obtained by contact with two 3/8-16 setscrews.



Regardless of how the bolts are turned, it is necessary to center both ends for grinding purposes, thus, there is no additional expense. Since this new method eliminates the slow, conventional method of holding the bolts in a chuck, production is increased.

Questions And Answers

Question No. 306

Are Gaskets and Packing Supplies or Maintenance?

IN WORKING UP power plant cost analyses, a question has come up regarding the proper classification of such items as gaskets, packings, etc. From information we have, there seem to be two schools of thought.

One of these considers that packing and gaskets are part of the machinery that wears out, and any part of the machinery that wears out is automatically considered as a maintenance item. Such items as lamps, tools, hose, paint, brushes, rags, waste heat water, treatment water, are not

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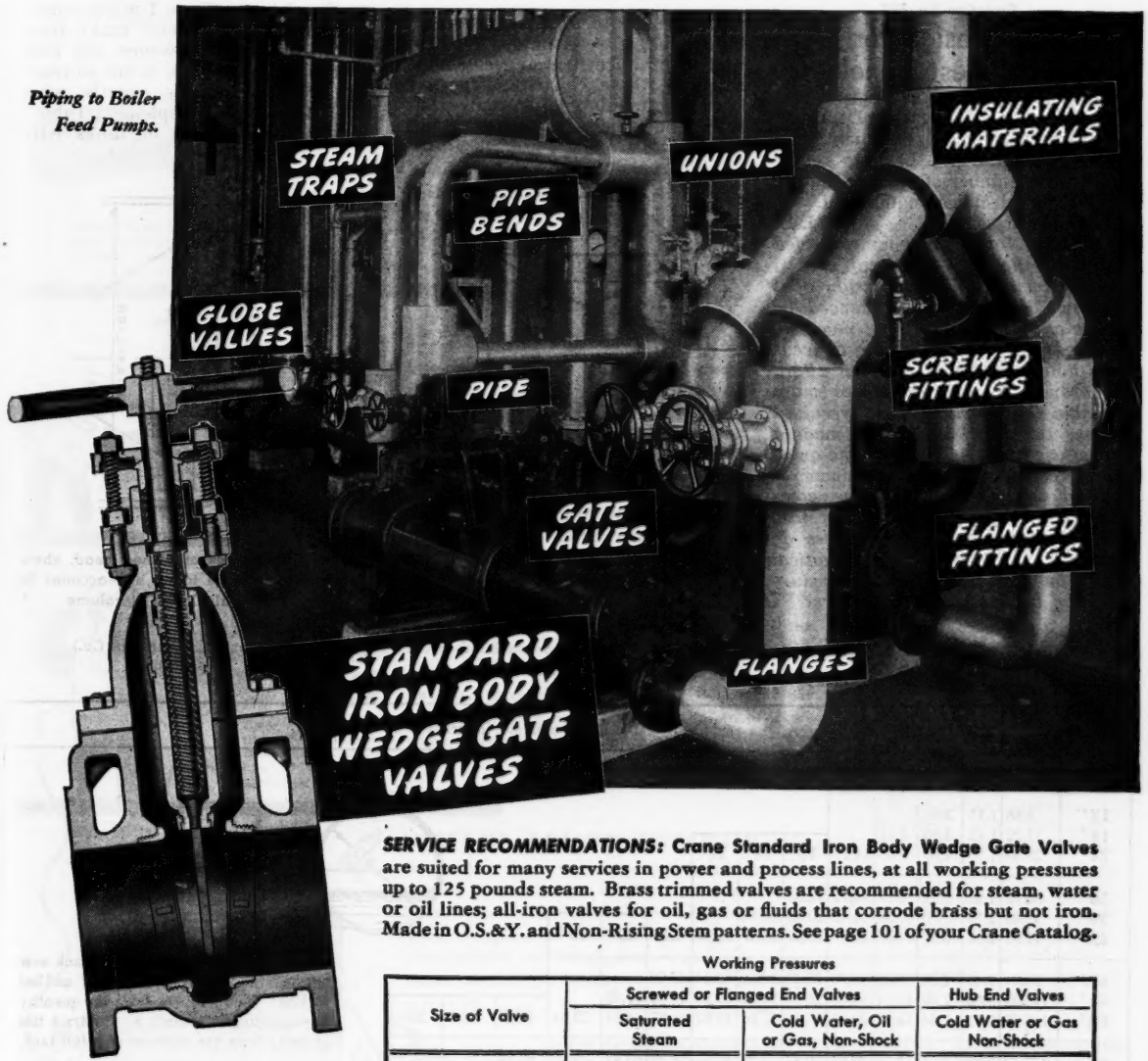
Piping to Boiler Feed Pumps.



SERVICE RECOMMENDATIONS: **Crane Standard Iron Body Wedge Gate Valves** are suited for many services in power and process lines, at all working pressures up to 125 pounds steam. Brass trimmed valves are recommended for steam, water or oil lines; all-iron valves for oil, gas or fluids that corrode brass but not iron. Made in O.S.&Y. and Non-Rising Stem patterns. See page 101 of your Crane Catalog.

Working Pressures

Size of Valve	Screwed or Flanged End Valves		Hub End Valves
	Saturated Steam	Cold Water, Oil or Gas, Non-Shock	Cold Water or Gas Non-Shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16-in., Crane 150-Pound Cast Steel Gate Valves are recommended. (For sizes under 2-in., use Crane Clamp Gate Valves.)

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part of the machinery as such, and are to be considered as supplies. Lubricants also are considered as supplies for, though they do wear out, they are operational expense.

The other school holds that such things as gaskets and packing are supplies because they need continual replacement.

I would like to see this subject discussed in these pages and learn how others classify these various items in their accounting systems.

Chicago, Ill. Z. K.

Question No. 307

Wanted: Design for Electrical Test Panel

CAN YOU give me a diagram and some ideas on a test panel for use in testing electrical equipment in a large hospital? We have to repair and test a number of 3-phase motors and other electrical equipment.

National City, Calif. E. J. B.

Editor's Note:—We have reminded E. J. B. that the design of such a panel is much like the design of a person's home, being influenced by what a person needs, how much he wants to elaborate on those needs and how much money he can afford to spend. We also asked for more specific details but have not received them. Despite this, we have made a lot of assumptions and sent the questioner a diagram of a panel incorporating our ideas, with some comments on equipment he might use. Will interested Q & A readers do likewise, thus bringing out practical data on test panels and procedure for the benefit of other readers?

Question No. 308

What Are Formulas for Tank Capacities at Various Levels?

CAN YOU give me the formulas for calculating the capacities of horizontal cylindrical tanks containing liquid at any given height and for various tank sizes, both for flat end tanks and also for tanks with concave and convex heads?

New York City W. F. W.

Editor's Note—When giving him the formulas, we reminded W. F. W. that in practice it is unnecessary to calculate these capacities, for they have been tabulated in various standard handbooks and other publications.

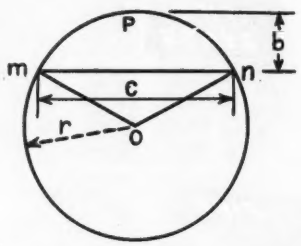

Fig. 1. Dimensions of circular segment for finding area

On page 104, March, 1943, issue of POWER PLANT ENGINEERING we published a chart of capacities for fuel oil tanks at various liquid levels.

We also referred to both Marks' and Kent's Mechanical Engineers' Handbooks, and to the Piping Handbook by Walker and Crocker, all of which contain tank capacity tables. In The Water Conditioning Handbook, published by The Permutit Co., he will also find the two tables reproduced here. Table I is the standard table for flat end tanks from Kent. Table II, however, for contents of dished heads, is not so readily available and is exactly what W. F. W. needs to supplement Table I for finding contents of tanks with

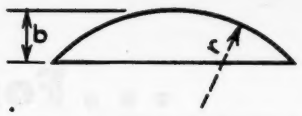

Fig. 2. Dimensions of spherical segment for finding its volume

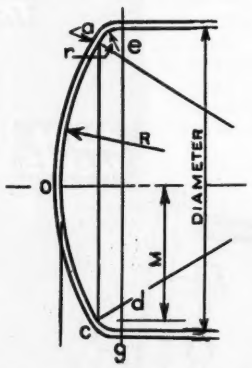

Fig. 3. Dimensions of dished head, showing how r must be taken into account for accurate calculation of volume

Table I. Contents of horizontal cylindrical tanks with flat ends when filled to various depths. (Courtesy The Permutit Co.)

Contents in U. S. gallons per 1 foot of length.

Diameter of tank inches	Full tank	Depth of liquid, in inches = h																						
		3"	6"	9"	12"																			
12"	5.88	1.15	2.94	.....	.....																			
18"	13.22	1.45	3.86	6.61	.....																			
24"	23.50	1.70	4.60	8.05	11.75	15"	18"	21"																
30"	36.72	1.91	5.23	9.27	13.72	18.36	.....	.....																
36"	52.88	2.12	5.79	10.34	15.43	20.85	26.44	.....																
42"	71.97	2.28	6.31	11.31	16.97	23.07	29.47	35.99	24"	27"	30"													
48"	94.01	2.45	6.78	12.20	18.38	25.10	32.20	39.54	47.00	.....	.....													
54"	118.98	2.60	7.22	13.04	19.68	26.97	34.72	42.80	51.08	59.49	.....													
60"	146.89	2.75	7.64	13.82	20.91	28.72	37.06	45.82	54.87	64.11	73.44	33"	36"	39"										
66"	177.73	2.89	8.04	14.56	22.07	30.37	39.28	48.65	58.39	68.41	78.59	88.86	.....	.....										
72"	211.52	3.02	8.42	15.26	23.17	31.92	41.36	51.32	61.71	72.45	83.41	94.54	105.76	.....										
78"	248.24	3.15	8.78	15.94	24.21	33.41	43.34	53.86	64.87	76.27	87.97	99.90	111.97	124.13	42"	45"	48"							
84"	287.90	3.26	9.12	16.57	25.24	34.85	45.24	56.29	67.87	79.91	92.30	104.98	117.85	130.87	143.95	.....	.....							
90"	330.49	3.43	9.46	17.20	26.20	36.21	47.05	58.61	70.75	83.39	96.43	109.81	123.45	137.28	151.23	165.25	.....							
96"	376.02	3.50	9.79	17.80	27.13	37.52	48.81	60.84	73.52	86.73	100.39	114.44	128.79	143.40	158.17	173.06	188.01	51"	54"	57"	60"			
102"	424.50	3.61	10.10	18.37	28.01	39.00	50.49	62.99	76.18	89.94	104.20	118.89	133.92	149.25	164.81	180.53	196.37	212.25	.....	.....	.....			
108"	476.10	3.71	10.39	18.94	28.90	40.03	52.14	65.09	78.74	93.04	107.87	123.17	138.87	154.89	171.19	187.71	204.37	221.14	238.05	.....	.....			
114"	530.25	3.78	10.74	19.49	29.75	41.22	53.73	67.10	81.24	96.05	111.43	127.31	143.63	160.33	177.33	194.60	212.05	229.65	247.37	265.13	.....			
120"	587.54	3.91	10.98	20.02	30.57	42.39	55.26	69.06	83.65	98.95	114.87	131.32	148.25	165.58	183.27	201.24	219.46	237.87	256.43	275.08	293.77			

To ascertain the contents of a tank over one-half full: Let h = depth of unfilled portion. Find from the table the quantity corresponding to a depth h. Subtract this quantity from the contents of a full tank.

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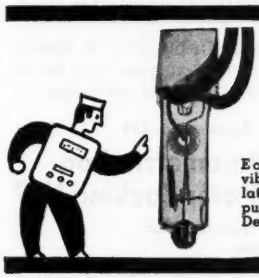
HOW HAYS COMBUSTION CONTROL

gives you 1 accuracy • 2 sensitivity • 3 speed • 4 power

This Hays slack diaphragm type measuring element reports each change

1 ACCURACY A CONSPICUOUS FEATURE

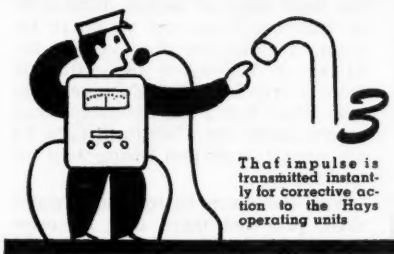
of Hays elements for measuring the minute changes constantly taking place in variable combustion factors—the Hays diaphragm type measuring element for draft and low pressures; and Hays Metallic Bellows for measuring steam or high pressures in air, water or oil.



Each measured vibration is translated into an impulse by Hays Pilot Device

2 TO CONVERT EACH MEASUREMENT

into an impulse calls for a pilot device of extreme sensitivity. The Hays pilot consists of two mercury switches magnetically operated. Fully enclosed, their contacts are effectively protected from dust, dirt, moisture; and blanketing with nitrogen prevents oxidation—a guarantee of long life.



That impulse is transmitted instantly for corrective action to the Hays operating units

3 THAT IMPULSE IS TRANSLATED

into corrective action, delivered instantly to the remote power units operating fuel feeder and air supply by electrical transmission. The Hays system possesses excessive starting torque—25 to 75 per cent higher than moving power—ample to overcome inertia and create quick action.

Hays power units respond—move dampers, valves, levers to correct position

4 INSTANT ACTION FOR MOVING

dampers, valves or levers *to the right point for accurate control* is the function of Hays power units. Motors are fully enclosed, effectively insulated, designed for installation in high ambient temperatures. Manual operation is available. Many sound features assure easy maintenance and long, useful life.

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2. How that Purpose is accomplished—3 methods of control.
3. What results can be expected of each.
4. Elements of a *good* control system.
5. Elements of a good controller.
6. *Coordinating* the controllers.
7. Selecting the best system for your needs.
8. How Automatic Combustion Control operates.
9. How each individual controller operates.
10. How controllers are calibrated and adjusted to fit requirements.
11. How controllers are stabilized to prevent hunting or over-travel.
12. Typical installations of Automatic Combustion Control.

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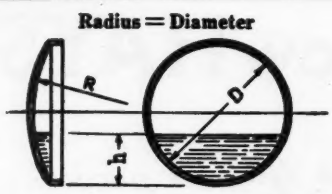
MICHIGAN CITY, INDIANA, U.S.A.

Table II. Contents of standard dished heads when filled to various depths. (Courtesy The Permutit Co.)

Contents in U. S. gallons for one head only. This table is only approximate but close enough for practical use. As prepared by Lukens Steel Company.

Diameter of head inches	Full head	Depth of liquid, in inches = h																					
		3"	6"	9"	12"	15"	18"	21"	24"	27"	30"	33"	36"	39"	42"	45"	48"	51"	54"	57"	60"
12"	0.40	0.05	0.20	.....	.....																
18"	1.36	0.07	0.32	0.68	.....																
24"	3.22	0.08	0.41	0.95	1.61	15"	18"	21"													
30"	6.30	0.10	0.49	1.18	2.10	3.15	.....	.....													
36"	10.88	0.11	0.56	1.39	2.54	3.92	5.44	.....													
42"	17.28	0.12	0.63	1.59	2.94	4.64	6.57	8.64	24"	27"	30"										
48"	25.79	0.13	0.68	1.75	3.31	5.29	7.62	10.19	12.89	.....	.....										
54"	36.72	0.14	0.74	1.90	3.64	5.91	8.60	11.65	14.95	18.36	.....										
60"	50.37	0.14	0.82	2.07	3.98	6.49	9.54	13.03	16.87	20.96	25.18	33"	36"	39"							
66"	67.04	0.15	0.83	2.19	4.25	6.98	10.35	14.30	18.68	23.43	28.42	33.52	.....	.....							
72"	87.04	0.16	0.88	2.32	4.52	7.47	11.15	15.48	20.38	25.74	31.46	37.43	43.52	.....							
78"	110.66	0.17	0.93	2.44	4.79	7.97	11.94	16.65	22.02	27.97	34.39	41.16	48.20	55.33	42"	45"	48"				
84"	138.22	0.18	0.98	2.59	5.07	8.44	12.69	17.78	23.60	30.11	37.19	44.75	52.67	60.83	69.11	.....	.....				
90"	170.01	0.18	1.00	2.68	5.33	8.91	13.44	18.86	25.12	32.18	39.90	48.22	56.99	66.14	75.52	85.00	.....				
96"	206.32	0.20	1.07	2.83	5.59	9.36	14.14	19.90	26.60	34.17	42.52	51.53	61.13	71.22	81.66	92.34	103.16	51"	54"	57"	60"
102"	247.48	0.22	1.14	3.01	5.89	9.87	14.92	21.01	28.11	36.18	45.19	54.91	65.31	76.29	87.73	99.56	111.59	123.74	.....	.....	.....
108"	293.77	0.20	1.13	3.03	6.04	10.21	15.50	21.93	29.47	38.03	47.56	57.97	69.14	81.05	93.53	106.47	119.76	133.26	146.88	.....	.....
114"	345.51	0.21	1.16	3.12	6.25	10.55	16.06	22.80	30.70	39.73	49.81	60.88	72.85	85.61	99.05	113.07	127.56	142.41	157.51	172.75	.....
120"	402.27	0.21	1.19	3.23	6.47	10.93	16.68	23.70	31.96	41.43	52.04	63.73	76.40	89.95	104.32	119.39	135.04	151.15	167.62	184.32	201.13



To ascertain the contents of a head over one-half full: Let h = depth of unfilled portion. Find from the table the quantity corresponding to a depth h. Subtract this quantity from the contents of a full head.

dished heads. Finally, we present the following comment.

In using the formulas, be sure your measurements are all in inches or all in feet. U. S. gallons = cu in. × 0.00433 = cu ft × 7.48.

How Tank Capacities Are Calculated

CONCERNING tank capacities, we have a set of tables, published by the K and G Chart Co., Alliance, Ohio, which we purchased several years ago. These tables give capacities of horizontal tanks, 24 in. to 144 in. in diameter inclusive, in increments for every inch of depth, based on tanks with flat heads. Capacities of dished heads for every inch in depth of 24-in. to 144-in. diameter tanks are also given, based on varying ratios of amount of dish to diameter of tank.

Therefore, to obtain an accurate volume it is necessary to combine the volume of the spherical segment, aoc, the frustrum of cone eacd and the volume of the sector of a circle section dcg, which is equal to the cross-section area of the sector multiplied by the circumference of a circle whose radius M is the distance of the center of gravity of the sector from horizontal center line of tank.

For an ASME dished head, in which the corner radius r equals 6 per cent of the tank diameter and the radius of dish R equals the tank diameter, the capacity in gallons is obtained by cubing the tank diameter in feet times 0.60.

East Chicago, Ind. L. A. WILKIN
Manager, Development Dept.
Graver Tank & Mfg. Co., Inc.

Formula for Area of Circular Segment mpn, less than half circle. See Fig. 1.

$$\text{Area} = \text{Area of sector, mpno} - \text{area of triangle mon,}$$
$$= \frac{(\text{Length of arc mpn} \times \text{radius r}) - [(\text{radius r} - \text{rise b}) \times \text{chord c}]}{2}$$

A simpler means of obtaining areas of circular segments is the use of tables as given in the Pocket Companion Handbook, published by the U. S. Steel Corp., in which the above formula is also given.

The formula for the volume in a dished head, see Fig. 2, is the same as for a spherical segment, which is,

$$\frac{\pi}{3} b^2 (3r - b).$$

The volumes at various depths can be determined from proportional areas as found by the circular segment formula given above.

Actually, all dished heads have a small corner radius as shown in Fig. 3, noted as r.

Answer No. 283

Can He Control Gas Engines from Steam Heating System?

Yes, They Are Still Very Much in Business

A READER stated in the July issue that control of gas engines from steam heating system pressure could be carried out with either of two regulators, one of which, he said, was the Locke Type 40-A-T, but he was not sure if the manufacturer of this regulator was still in business.

Seeing this remark, Locke Regulator Co. hastens to assure us—and we are glad to report it—that it is still very much in business in Salem, Mass., and that next year will be its 75th continuous year of operation.

Answer No. 294

Why Is Barometric Condenser Water Backing Up?

Mullen, Back from the War, Gives His Ideas

WHEN HGS. asked this question in the April issue, it lacked quite a bit of information on the set-up in his plant. I didn't see this question until late in May after just getting in from a trip from the European war area. Now that I will have some time on my hands for a while thought I'd see what I could find wrong with the hook-up.

Yes, there can be too much water used, provided there isn't an overflow.

One sub-question asks, Could it be anything like the case described in the April issue, on pages 48, and 49? Although the sketches look almost alike, there is quite a difference.

The sketch, p. 49, April issue, shows a turbine-driven generator; it doesn't show whether it was high-pressure, low-pressure or exhaust steam-driven. Also, the April sketch shows the exhaust from the turbine being higher than the injection water inlet. It shows no means of withdrawing the air by means of a dry air-pump, shows no overflow which would cause water to back up through seal ring drain line. If the drain line from carbon seal ring had been exposed just above the top of hotwell and equipped with a check valve, it would have prevented what the engineers found to be the cause, siphoning from the hotwell.

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SEE OUR CATALOG IN SWEET'S

Page 2H-8, Power Plant File

★ **"THE STORY BEHIND THE GASKET THAT BREATHES"**

Note on this cutaway drawing, the small air space under each U-groove in the metal ply.

There are twin strips of asbestos filler between each spiral thickness in the AJAX Gasket which cannot meet in the center under the wedge-like groove. Therefore a "breather-space" is preserved in the heart of the gasket which assures its automatic reaction to mechanical compression, to internal pressure variation, and to temperature changes.

The AJAX Gasket expands and contracts — "breathes" — with changing pressure conditions — and retains the positive, secure seal you require at all times.

The above cutaway is the AJAX SR Compression Gauge Flange Gasket

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A question that bothers me is: since when does the engineering force allow salt water to mix with the condensate? An alert force would have checked the feedwater at least once an hour for salinity. This is done in marine practice every hour in all types of steam plants, especially where turbines are operated, also when using fresh water on Diesel engines, where this water is cooled by salt water means. Can't understand any Chief letting a condition of this sort exist.

In the May issue sketch, page 116, this condenser looks all right at a first glance but checking it over shows it has a few mistakes (I'm sticking my neck out, as we small plant operators will from time to time.)

The air vapor outlet (new name for a vent, eh?) doesn't show a dry-vacuum or air pump and, not having one of these, there would be an atmospheric condition created with the outlet just extending to the outside.

Why not just condense the steam used instead of using the cooling water from the refrigeration unit? There must be quite a lot of compound used in this arrangement due to the mixing of the cooling water of the refrigeration system with the condensation from the steam system. A leak from the ammonia system would make a bad water condition. With a plant of this sort, I think a closed condenser would be better and not have the refrigeration system connected up in any way with the steam.

If the barometric condenser was installed with a dry air pump at the point where the air vapor outlet is shown, and hooked, it would probably be all right, provided the treated water was checked often, because of the travel of this water through the refrigeration system.

Although it has been said that the tail pipe is clean, how about the baffle (in the May sketch) over the exhaust steam inlet to the condenser? This could have broken off and fallen into the bottom of condenser at the top of the tail pipe, partially closing this pipe and causing condenser to fill up, due to the water not getting away from the condenser to the hotwell.

I don't think the refrigeration condenser is heating the water too much, because, with the air outlet pipe extending to the outside, this condenser would act more like a receiver and the hottest the water would become would be 212 F.

If the pumps weren't operating properly, it would mean that the discharge from the hotwell wouldn't be taken out as fast as it should and the hotwell would overflow. When this happens then it's time for the operator or engineer to check what is wrong. Water being wasted is money going down the sewer.

Philadelphia, Pa. WM. T. MULLEN

One of them small plant fellers

Answer No. 296

Should These Turbine Generators Be Installed or Should Power Be Bought?

C. F. M.'s plant purchases about 136,000 kwhr a month, demand charge $740 per month, rate $0.016 per kwhr. Present day load 425-450-kw; Sunday and holiday load about 125-kw. The management wants to purchase two 750-kw turbine generator units, to operate at 5 or 6 psi back pressure, exhausting to a building heating load of about 200-bhp for 8 months of the year. There is no other use for the exhaust steam. G. F. M. says they have no water facilities for condensing operation. Cost of coal only in present boiler room, 21.9 cents per 1000 lb steam.

C. F. M. asks if the two turbine generators would be a paying proposition.

Calculation of Savings by Generation

C. F. M.'s problem may be analyzed as follows: Assume the electrical loads as tabulated below.

Kw	Hrs	Kw-Hr	Days per Wk	Kw-Hr per Wk
405	8	3240	6	19,440
100	16	1600	6	9,600
100	24	2400	1	2,400
			Total	31,400

31,400 × 4.33 Weeks per Month = 136,000 Kw-Hr
@ $0.016 = $2176.00

Assume new turbines designed for 100 psig throttle pressure and 5 psig exhaust pressure. Water rates, steam usable and steam wasted would be about as tabulated below:

Kw	Steam Lb per Hr	Exhaust Steam Usable	Exhaust Steam Wasted	Hrs	Lb per Day	Days per Wk	Total
405	18300	6600	11700	8	93600	6	561,600
100	9500	6600	2900	16	46400	6	278,400
100	9500	6600	2900	24	69600	1	69,600
						Total	909,600

909,600 × 4.33 Weeks per Month = 3,940,000 Lb
wasted from Oct. 1 to May 1

During the period May 1 to Oct. 1, all the exhaust steam would be wasted. This may be calculated in a similar manner, as follows:

18300 × 8 = 146400 × 6 = 878,400
9500 × 16 = 152000 × 6 = 912,000
9500 × 24 = 228000 × 1 = 228,000
Total 2,018,400
× 4.33 = 8,710,000 Lb
Cost of Purchased Electricity = $2176. × 12 = $26,112.
Cost of Generated Electricity =
3940 × $0.219 × 7 = $6,040.
8710 × 0.219 × 5 = 9,550.
$15,590. 15,590.
Gross Saving by Generating $10,522.

The foregoing analysis has been simplified by neglecting heat in steam utilized for power generation and cost of additional input to generate steam at 100 psig instead of the 5 psig which would otherwise be sufficient. These corrections tend to offset one another and the net effect on the result shown would be very slight.

Now to answer the question. C. F. M. states that he has no figures on the steam consumption of the turbines. Since the manufacturer would gladly furnish such information, it would appear that the turbines in question are second hand. In this case they probably were designed for different steam conditions and their water rates may be considerably more than those indicated above for modern units properly designed to meet the required operating conditions.

If this should be the case and if due allowance is made for additional labor, supplies, maintenance, etc., as well as the fixed charges on the required investment, the gross saving calculated above may vanish and there might well be a loss. It is, furthermore, possible that, in the absence of process as well as heating steam from May 1 to Oct. 1, the boiler plant might be shut down completely. In this event considerable boiler room labor would have to be charged against power generation.

In closing, one word of advice. Never install second hand turbines without a knowledge of the design conditions and the expected operating performance data under the proposed changed conditions. If new turbines are considered and condensing water may be obtained from a well, condensing extraction units are indicated. With them a fairly good balance between steam and electrical requirements should be obtainable.

Westbury, L. I., N. Y. ALFRED W. FOX

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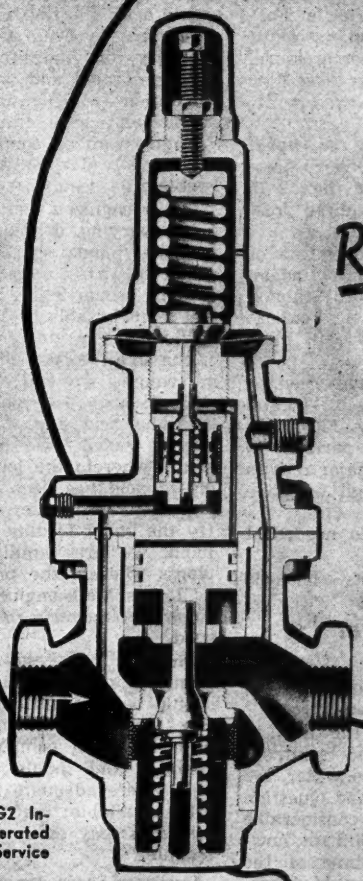

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Answer No. 297

How Make High-Pressure Steam Out of Low-Pressure Steam?

Steam Compressors Recommended

IN THE ANSWER to the question in the June issue under the editor's note, no mention was made of the use of steam compressors to accomplish this.

Editor's Note: We did not mention this because it seemed to us, from the context of the original question, that the questioner already knew about steam compressors and wanted to know if there were any other methods. In editing the question for publication, however, we failed to make that point clear—and failure to make things clear is a serious editorial fault. Sorry.

It has been demonstrated by the Central Heating Department of The Detroit Edison Co. to the complete satisfaction of several of its steam customers that the use of steam compressors, which increase the pressure of the available steam supply, is entirely satisfactory. The temperature of the compressed steam corresponds closely to the saturation temperature of the final pressure. The small amount of superheat is usually no more than is sufficient to offset the radiation losses in transmission.

Fifteen of these steam compressor installations have been made by customers who purchase steam from this company and the first unit which was placed in service in 1927 is still operating satisfactorily. These compressors, which are supplied by several different manufacturers, range in capacity from 50 lb per hour to 1800 lb per hour. The installations are in laundries, department stores, office buildings and health spas. The initial steam pressures are between 15 and 25 psi and the final pressures are between 60 and 80 psi.

We believe that steam compressors may be used economically in any situation where a supply of low pressure steam is available and a small amount of high pressure steam is desired.

Detroit, Mich. G. D. WINANS
Asst. Supt. of Central Heating
The Detroit Edison Co.

Here's How One Plant Does It with Steam Compressors

I AM IN CHARGE of a power plant with boilers limited to 160 psi, but operating at 150 psi. One of our processes requires steam pressures up to 295 psi, but process requirements at present time call for a pressure of 255 psi with final temperature of 420 F.

We supply these steam requirements by means of four steam compressors or boosters, each 8½ in. bore by 13 in. stroke, at 277 rpm. These compressors are driven by direct-connected synchronous motors. Each motor is 125 hp, 440 v, 131 amp (arm.) 1.0pf, 100 kva. Excitation, 230 v, 16.5 amp.

Each compressor has a capacity of 3400 lb of steam per hr, at delivery pressure of 295 psi, when supply pressure is 150 psi.

To desuperheat the steam from the compressors we use a steam driven duplex pump size 4 in. (steam) by 1¾ in. (water) by 5 in. (stroke), operated by steam at boiler pressure.

The plant was operating three 8-hr shifts, but at present we are operating on two 8-hr shifts.

When operating within the capacity of the compressors, delivery pressure does not vary more than 2 lb either above or below required pressure.

Control of pressure is by means of two-step unloading on the cylinders, also by means of a Foxboro Stabilog Controller operating a Foxboro Stabilflo valve on the steam main from the boilers.

These compressors have been in operation since August, 1944, and have supplied as much as 130,000 lb of steam during a 24-hr period. Up to the present time, no major repairs have been made, although we have had a few minor repairs.

If more information is needed, I can supply more details.

Woburn, Mass. CHARLES G. TURGISS

Answer No. 300

How Aerate Water to Remove CO_2

Acid Proportioning and Aeration Not So Simple as Answers Make Them Appear

HAVING BEEN one of the first to "carry the torch" for acid treatment and aeration of boiler feedwater, the answers to Problem 33 and Question No. 300 have been of considerable interest to me. I find it difficult, however, to concur with some of the opinions expressed and would appreciate the privilege of presenting my misgivings. These are offered, not in criticism of any individual, but in an attempt to extend the available information on the subjects in question. (Problem 33 was referred to in answering Question No. 300 in the June issue.—Ed.)

Acid Proportioning—Problem 33

The general treatment given to Problem 33 seems to imply that the proportioning of acid to boiler feedwater is a naive undertaking; that it can be accomplished by using untried proportioning equipment or by selecting one of the commercially available devices proffered for the purpose. My experience does not substantiate either of these contentions.

Prior to the war we had occasion to survey the field of commercially available equipment of this type but were so unimpressed with the designs studied that it was decided to attempt to develop such a device. This was done, and the proportioner has since demonstrated its reliability in two different plants. This development, however, necessitated, not only the collective effort of a number of experienced designing engineers, but, in addition, considerable field experimentation.

The finished product assumes the nature of a metering device. In its development, the selection of the proper materials to resist dilute sulphuric acid; the importance of small differences in head on orifices; the necessity for guaranteeing adequate mixing of acid and water; and the precautions which must be taken to provide an acid solution of the same strength were all found to be much more involved than the answers to Problem 33 seem to connote.

It is recognized that, from plant to plant, varying degrees of precision may be mandatory. But, for most power plants, even where only "rough" proportioning is required, we feel it inadvisable to attempt to proportion concentrated acid (1) because of the small volume of acid required per volume of water and (2) the serious damage that may be done before the acid and water are thoroughly mixed. We have witnessed plants wherein the loose proportioning of acid has necessitated (a) replacement of a boiler feed pump and (b) the boiler feedline. On the other hand, we are familiar with other plants wherein the proportioning of acid was well engineered, and entirely satisfactory results have ensued.

In view of these experiences, it seems to me the practical engineer should be admonished; that, in most cases, acid proportioning should be regarded as a complex engineering problem and should be undertaken only where adequate technical counsel is available; that the use of contraptions may easily lead to serious troubles.

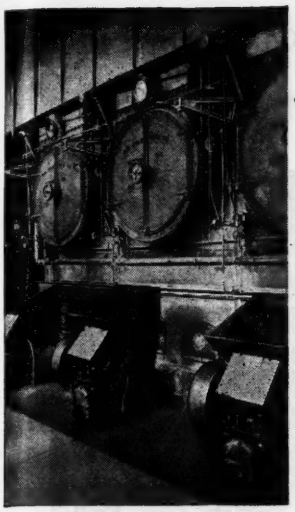
Aeration of Feedwater—Question No. 300

In the answer to this Question, theoretical reasons are advanced to imply that the primary purpose for using a degasifier is to prevent "overloading" of the deaerating feedwater heater with gaseous CO_2. We have no quarrel with the theory, but we believe an even more important function of a degasifier is to remove the "bulk" of the CO_2 in order to reduce, proportionately, corrosive attack of the feedwater piping preceding the deaerator and those parts of the deaerator contacting the incoming water.

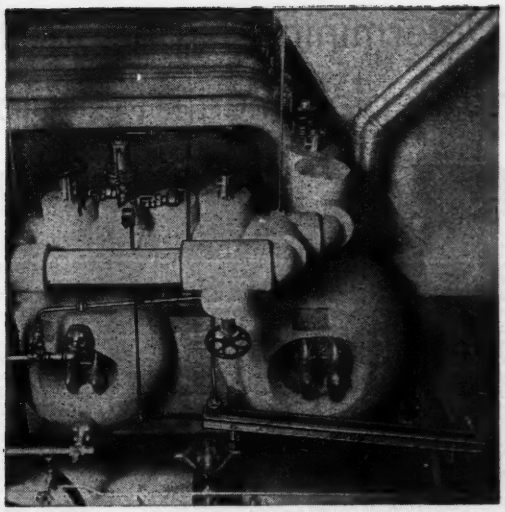
Tests of short duration have been conducted in which the degasifier was eliminated, and the residual CO_2 in the deaerator effluent was found to be not measurably higher than with the degasifier in service.

Some of the leading deaerator manufacturers have been toying with the idea of producing units that will permit of the proportioning of acid just ahead of the heater—even to the point of making the water definitely acidic—thus eliminating the use of a degasifier. The finding of a material for fabrication of the heater that will withstand the more corrosive water, rather than changes in fundamental design of such units, appears to be the problem to be solved.

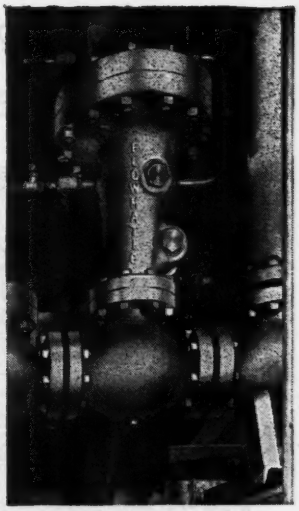
Detroit, Mich. LEO F. COLLINS,



Atlanta Ice & Bottling Co., Atlanta, Georgia. 3 Copes Type OT Regulators installed on HRT Boilers operating at 100 pounds pressure.



Industrial Plant. One of two feed lines to 650-pound pressure C-E Boiler handling a peak of 150,000 pounds per hour, controlled by a Copes Type BI Regulator and Type 3-S-2 Differential Valve.



Eddy Paper Corp., White Pigeon, Mich. Direct-operated Copes Flowmatic Regulator Valve on 550-pound Badenhausen Boiler.

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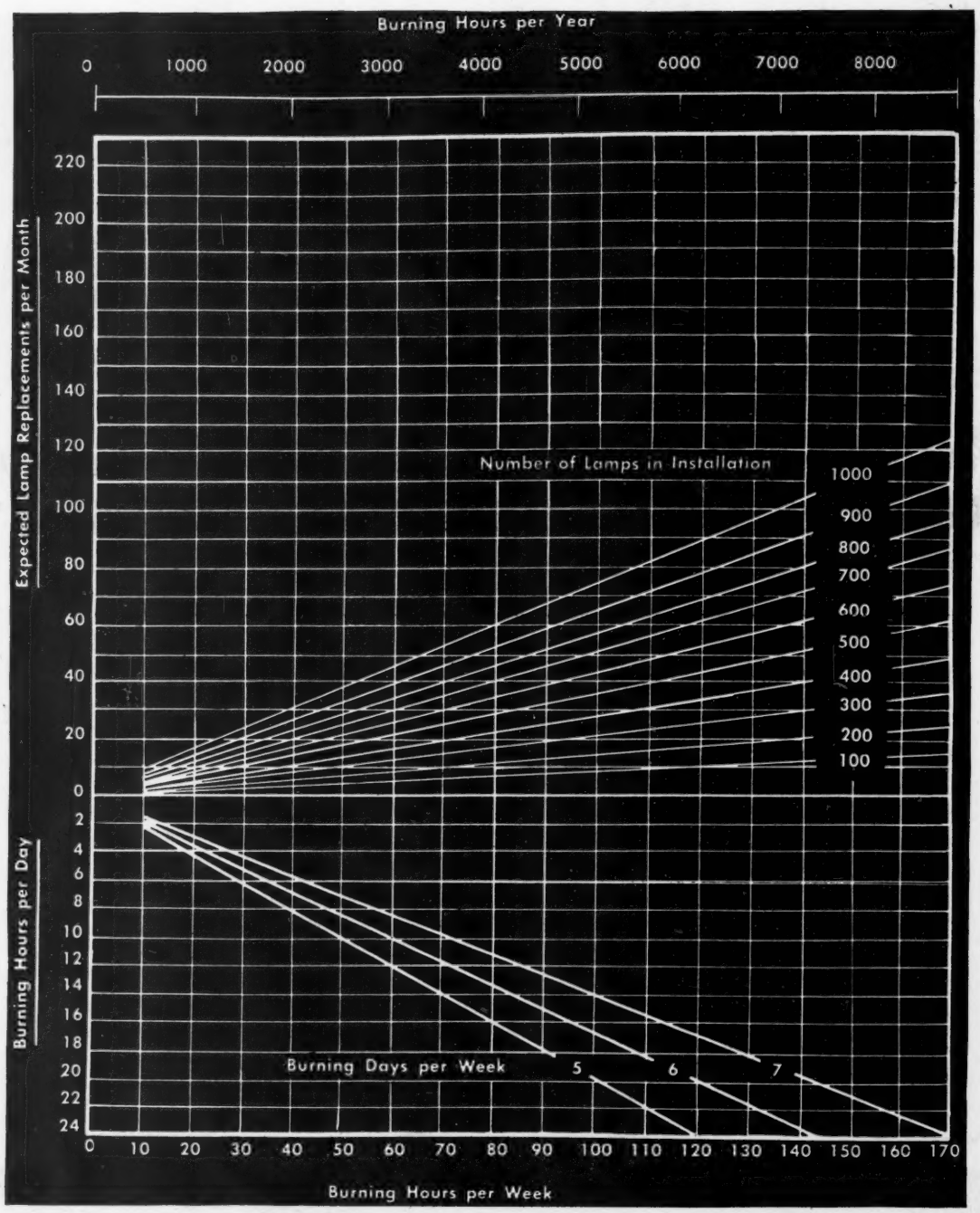
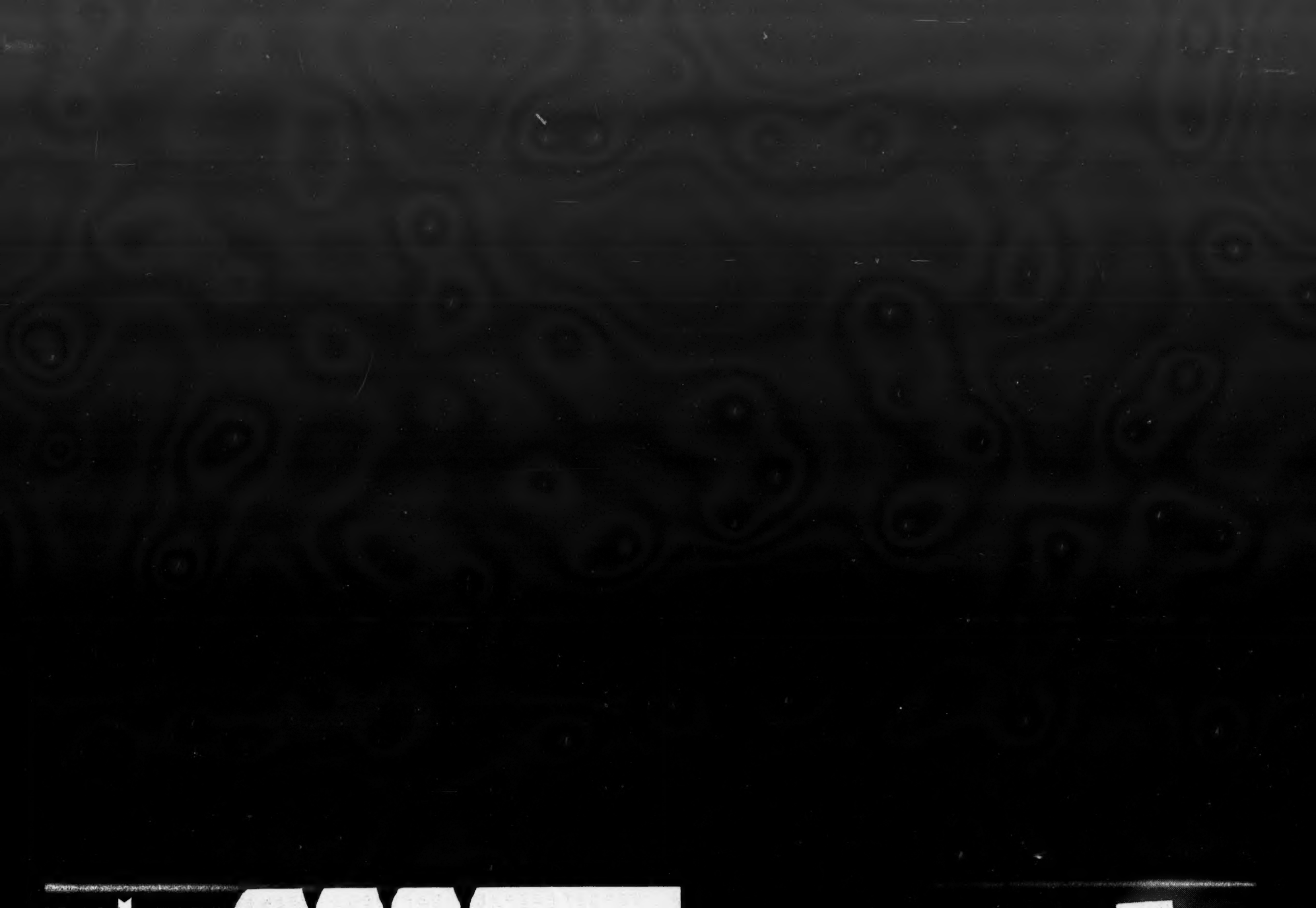
Chart for Determining Expected Fluorescent Lamp Replacements Per Month



This chart is based on a rated average lamp life of 6000 hours.

Note.—See page 112 of August issue for a similar chart based on an average lamp life of 4500 hours

Presented by courtesy, Sylvania Electric Products Co.



SUN DIESEL LUBRICANT... Ends Carbon and Gum Formation... Eliminates Sticking Valves... Lasts 50% Longer

Carbon and sticky deposits were black marks in the power-picture of an eastern candy-maker. In the operation of an eight-cylinder Diesel, direct-connected to an electric generator, he was using a well-known brand of Diesel lubricant which was changed every 200 hours.

Frequent shutdowns were scheduled for carbon-cleaning, for freeing stuck valves, and for general engine-repairs.

The difference in lubricants was soon proved when a Sun Oil Engineer studied the operating-conditions and recommended a Sun Diesel Lubricant for that particular type of Diesel engine.

Fifty percent increase in oil-life was noticed with the new oil in the crankcase. Oil-changes were soon scheduled every 300 hours instead of 200. Shutdowns for stuck valves, sticky deposits, and carbon-trouble due to faulty lubrication, were eliminated. These facts are typical of the results being obtained in all kinds of plants and all types of machines with Sun Industrial Lubricants and Sun Engineering Service. For power-equipment, compressors, machine-tools, hydraulic systems . . . in mills, mines, and factories . . . there's a Sun Product to help speed production and cut costs. Write for full details to . . .

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OILS FOR AMERICAN INDUSTRY

Elliott Co. Completes Marine Gas Turbine Power Plant

Develops 2500-hp net coupling output, designed for first application in marine propulsion . . . Includes the Lysholm positive-displacement compressor . . . Cycle employs high and low pressure turbines and compressors, regenerator and intercooler . . . Problems in design and manufacture . . . Starting and operating procedure described

PRESAGED by the data presented to readers of POWER PLANT ENGINEERING 18 months ago,* by Messrs. Soderberg and Smith, the Elliott Co.'s gas turbine power plant, designed for first application to ship propulsion by the U. S. Navy, has been completed and at this writing is undergoing extensive performance tests in the company's shops at Jeannette, Pa.

This unit is the first to be completed in the United States exclusively for power generating purposes, according to its manufacturer. Its operation was demonstrated before a large group of U. S. Navy and shipbuilding representatives and technical magazine editors on June 25, 1945, bringing to a conclusion two years of work.

Its principal features are:

1—Use of a positive-displacement type air compressor of new design, delivering fixed volumes of air independent of discharge pressure, thus providing great flexibility in operation over a wide load range, an important factor in marine applications.

2—Simple control and operating procedures.

3—Use of a regenerative and intercooling cycle with two compressors and two turbines.

4—Solution of many operating problems by ingenuity in both design and fabrication of elements.

5—Operating efficiencies of the order of about 30 per cent.

6—Weight of about 30 lb per hp and volume of about 3.5 cu ft per hp.

Basis of Design

Many combinations of turbines, compressors, combustion chambers, intercoolers, and regenerators can be used to produce a good, workable gas turbine plant, as shown in Fig. 5.

A regenerator has the greatest single effect in raising the efficiency of the machine. The addition of an intercooler and a second combustion chamber and turbine also increase the expected economy. The use of still another stage of intercooling and reheat are also shown to be advantageous but, as is seen, the gains become progressively smaller. However, as the number of elements is increased, they become reduced in size and are consequently easier to build.

With these theoretical considerations in mind, Elliott Co. has elected to build a plant composed of two turbines, two compressors with intercooling, two combustion chambers, and a regenerator as shown in Fig. 3.

Principles of Operation

The flow of gas in this unit begins at the low-pressure compressor, which draws in free air and compresses it to 43 psi absolute and 300 F. The air temperature is then lowered in the intercooler, whereupon the air passes directly into the high-pressure compressor, which raises the pressure to 96 psi absolute. The air then passes through the regenerator, where it picks up a portion of the heat in the turbine exhaust gas before it enters the high-pressure combustion chamber.

In the high-pressure combustion chamber, fuel oil is burned directly in the air stream and a temperature of 1230 F is reached at the entrance to the high-pressure turbine. In this turbine, the heated air is expanded to 53 psi absolute, and in doing so sufficient power is developed to drive the low-pressure compressor.

The gas from the high-pressure turbine exhaust is then reheated in the low-pressure combustion chamber to raise its temperature to 1207 F before it is expanded in the low-pressure turbine. Five thousand horsepower is realized from the low-pressure turbine, 2500 hp of which is expended in driving the high-pressure compressor. The remainder of 2500

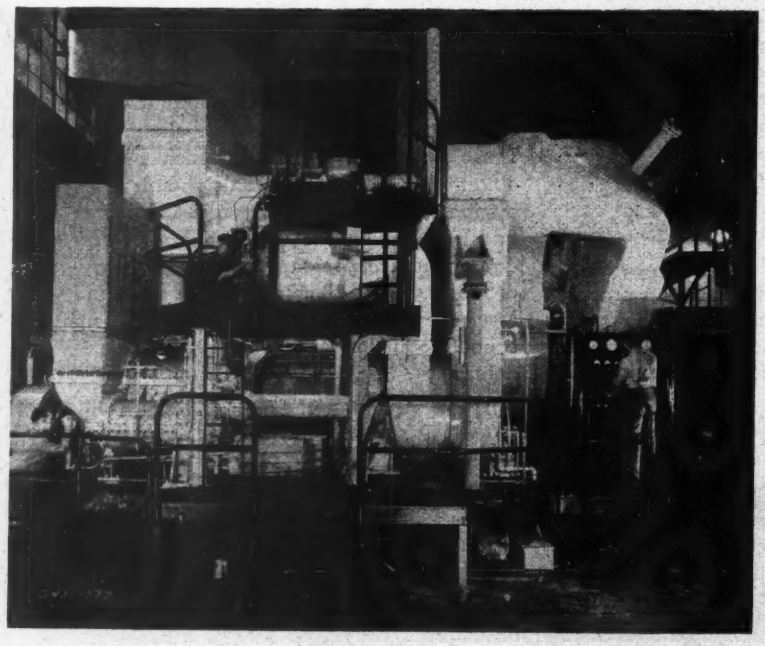
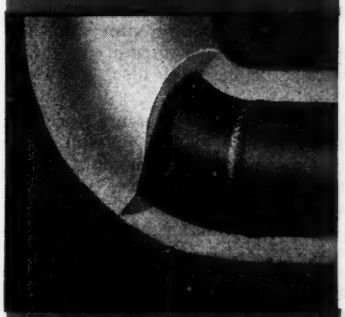


Fig. 1. View of Elliott gas turbine plant in shop, undergoing extensive performance tests

*The Gas Turbine—Present Status and Future Prospects, by C. Richard Soderberg and Ronald B. Smith; Power Plant Engineering, April, 1944.

ONCE DONE...

The larger the pipe, the greater the insulation saving contributed by streamlined Tube-Turn welding fittings.



Insulation fits smoothly because elbows and pipe form one continuous tube; no bolts to tighten, no gaskets to leak.

IT'S INSULATED FOR KEEPS!

In Cleveland's modern municipal power plant, the Tube-Turn welding fittings were as easily insulated as the pipe, because the welds form one continuous tube. There will be no future expense and trouble removing and replacing insulation every time bolts need drawing up or leaky gaskets need replacement. Once insulated, a system using Tube-Turn welding fittings is insulated for keeps!

Furthermore, welding the 10" and 6" steam lines shown here saved approximately 55% in joint costs over flange connections. Other benefits of Tube-Turn welding fittings include lighter weight, greater strength, and increased efficiency of flow. Because they require less space, they permit more flexibility of layout.

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hp is excess power or net output which may drive a propeller or a generator or a locomotive.

After the gas leaves the low-pressure turbine at slightly above atmospheric pressure, it passes to the regenerator where it pre-heats the fresh compressed air from the high-pressure compressor. The exhaust gas passes up the stack at a temperature of 400 F and is discharged to atmosphere.

The two compressors are driven by separate turbines, a desirable feature in this case because naval power plants operate more than 90 per cent of the time at other than full load and it is therefore important to have highly efficient part-load performance. To reduce the power output it is necessary either to decrease the amount of hot air passing through the turbines or to reduce the temperature of the air. It may be necessary to do both.

Best efficiencies are realized when the temperature of the compressed air is as high as possible before it is put to work in the turbines. Thus, for best economy, it is desirable to operate at reduced power by decreasing the supply of compressed air rather than reducing the gas temperature. The best approach to high-temperature, reduced-flow operation is realized in this plant because the components are so arranged that the main power turbine can always be operated at full temperature.

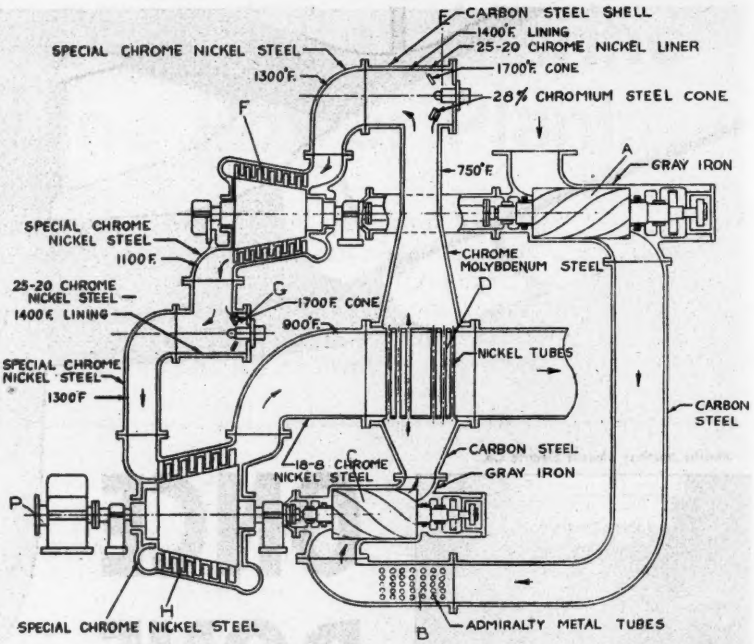

Fig. 3. Diagrammatic arrangement of Elliott unit, indicating metals used for various components. A—Low-pressure compressor. B—Intercooler. C—High-pressure compressor. D—Regenerator. E—High-pressure combustion chamber. F—High-pressure turbine. G—Low-pressure combustion chamber. H—Low-pressure turbine. P—Propeller shaft

Control and Operating Procedure

Complete control is obtained by regulating the fuel flow to the turbine driving the first-stage compressor. Since the amount of air which enters the system is controlled by this compressor, it is apparent that this one feature can produce ease of control and, at the same time, permit efficient operation of the main power turbine.

Operation of this gas turbine plant is as follows: To start the plant, a starting motor is first engaged to rotate the low pressure turbine-compressor rotor, fuel oil injection motor is started, one burner in the high-pressure combustion chamber is lighted, and the unit is warmed up. Rate of heating is controlled by operation of the throttle. When temperature of combustion gases at the high-pressure turbine inlet is high enough so that the starting motor can be dropped, the temperature of the low-pressure turbine will also be at a satisfactory value.

Speed of the low-pressure turbine is maintained at 200 or 250 rpm during warm-up by adjustment of electrically-controlled by-pass valves. Next the unit is floated off the starting motor by increasing the motor speed and increasing the fuel combustion rate. A second burner is lighted in the high-pressure combustion chamber, also a burner in the low-pressure combustion chamber and this brings the unit up to full output. To shut down the plant, it is necessary only to close the throttles, stop the injection motor and open the by-pass valves. Jacking gears are engaged when the rotors slow to about 10 rpm.

All controls are centralized at the control station where they can be operated by one man. Burners and tips need no adjustment or replacement for changing loads and the turbine inlet temperatures remain essentially constant with load variations. To increase the load the fuel throttles are opened; the turbine inlet temperatures tend to rise but the resulting increase in power developed

Fig. 2. The 12,500-cfm Elliott-Lysholm air compressor, with upper casing lifted, showing rotor. This consists of helical co-operating lobes, which intermesh. These lobes take the incoming air in successive overlapping bites, compress it by squeezing and force it out the exhaust, still in overlapping bites, to produce a steady flow. Quantity of air directly proportional to rotor speed and independent of discharge pressure

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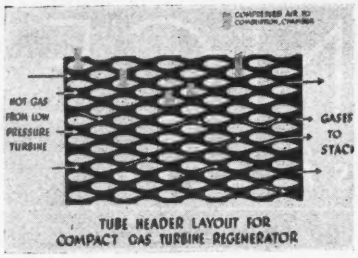

Fig. 4. Diagram showing construction of regenerator or heat exchanger. Streamlined nickel tubes are used

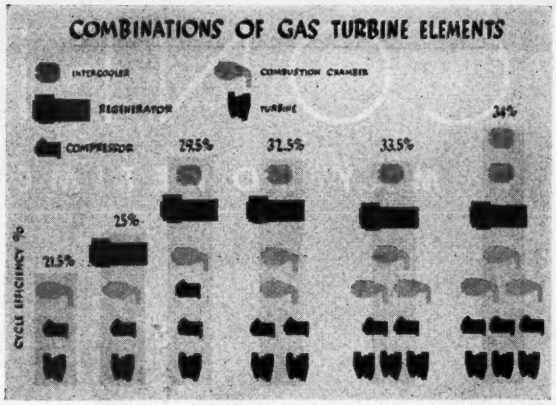

Fig. 5. Chart showing how various combinations of turbine, compressor, and heat exchange elements raise theoretical efficiency of gas turbine plant to about 34 per cent

tends to speed up the unit and simultaneously increases the air flow, thus tending to maintain constant turbine inlet temperature.

To achieve these results, with parts operating at temperatures of 1200 F, and other a few inches away at 200 or 300 F, a great deal of work went into the design of parts and the material from which they are made. A few comments on some of these features show that there are real problems here.

Expansion Details Important

The gas turbines must be made from materials which have a coefficient of expansion 50 per cent higher than ordinary steel. For example, the turbines are nearly ½ in. longer at operating temperature than when they are cold. This makes it necessary to design these machines so as to permit these expansions to take place in a short space, without pushing the machines from their foundations or breaking the connecting pipes. Thermal strains must not be imposed on the various machines, since the light-weight structures subjected to high temperatures may be seriously distorted.

Both the high and low-pressure turbines are solidly mounted at their exhaust ends, with all expansions taking place toward the inlet of the machines. To permit this, it was necessary to secure these floating ends by means of freely moving links. Relative movement between the turbines and the compressors they drive is absorbed by double flexible couplings and long torque-tube jack shafts. In the piping, flexible joints of conventional type are either not satisfactory for the temperatures and pressure encountered, or are too large to be used in this type of plant. It was therefore necessary to develop a new type of expansion joint.

The temperature at the inlet of the high-pressure turbine reaches 1230 F, yet at a point approximately 10 in. away, the metal temperatures must be below 200 F for proper operation of the main shaft bearings. To make this possible, systems of heat dams and special oil cooling at the bearings, and air cooling at the pin rings, are used. The pin rings at each end not only support the full weight of the turbine, but they are so constructed that a 600-F temperature drop takes place in the connections between them and the inlet casing. This is accomplished by using small areas of contact, reduced metal sections to cut down heat conduction, and some well-placed air cooling on the inside of the pin rings.

A further temperature drop takes place in the bearing casings, and here again a problem exists. The inside flange of the bearing casing reaches 550 to 600 F, but five inches away the temperature can be only about 200 F. This makes it necessary to have symmetrical and uniform sections for the wall of the casing, to prevent excessive and uneven temperature strains.

The shaft must be designed in a similar manner. The stub shaft ends have reasonably light walls so that the heat conduction is kept to a minimum. A radiation shield is installed inside the shaft to prevent exposure of the cool end of the shaft to the red hot inner regions. In addition to this, oil cooling is provided under the bearing journal sleeves.

All main members are tied together by radial pins which permit free movement between adjacent parts that experience temperature differences. In other words, the pin rings, the diaphragms, and the gland assemblies are all free to expand unrestrainedly with respect to their adjoining members. This is a heat-elastic design and construction which has eliminated many problems.

It was even imperative to get the machines unbolted after they had been operated at temperature. The stainless steel alloy which must be used in these turbines has the undesirable characteristic of galling when two parts are assembled. To take the nuts and bolts apart, a special colloidal silver compound was devised for applying to the threads to prevent this galling.

New Uses of New Materials

Because of creep it is certain that, after some period of operation, the turbine rotors will grow, the flat sided ducts will budge, and the round ducts will grow too large and too thin. It is the designer's problem to choose materials and loadings of such character that these changes will not be obnoxious before a certain definite time in terms of hours of operation. The present plant is designed for 10 years of continuous high-temperature service.

Figure 3 shows a schematic cycle, noting materials and temperatures in all major parts of the plant. The nickel torroidal joints in the high-pressure combustion chamber inlet were an interesting problem. This duct is made of chrome molybdenum steel to operate at temperatures up to 1000 F. The torroidal joints are spinnings, 0.025 in. thick. Nickel is usually a work-hardening material which cannot be spun but upon request a special grade of nickel was produced in very small quantities, which could be spun.

Castings, though simple and convenient to design, are hard to produce in high-temperature alloys. Because riveted joints depend primarily on tension in the rivet, they can be used only in minor attachments. In general, the only recourse in building such machines as this is to use rolled plate and arc welding, and by this method to fabricate many pieces into one permanent single assembly. This method was used in all the duct work and the combustion chambers in this gas turbine plant. The turbine rotors were assemblies machined from rolled plate and forgings, and welded into an assembly.

Extensive Use of Welding

The extended use of welding in the construction of a gas turbine plant brings up some interesting problems in connection with welding on materials for high-temperature service. The welding of 19-9 WMo material was a completely new problem. No welding had been done on this alloy prior to the design of this plant. To weld this material, it was necessary to develop a welding electrode, since all existing electrodes were tested and found to be short of the necessary high temperature strength.

In designing the rotors for the large Lysholm compressors used in this plant, it was necessary to use steel shafts. However, steel was not a

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PROBLEM: Valves for throttling service have always been tough to build. The punishing wear of partly-open operation takes its toll on even the best standard globe type valve, and of course a gate valve in throttling service is seldom satisfactory. Not long ago a large Eastern utility came to Edward with a request for a valve specifically built for severe throttling service. Edward engineers, working with the customer, produced the valves described below. Originally designed for use on a feedwater pump by-pass line, they are ideally adapted to general throttling service.

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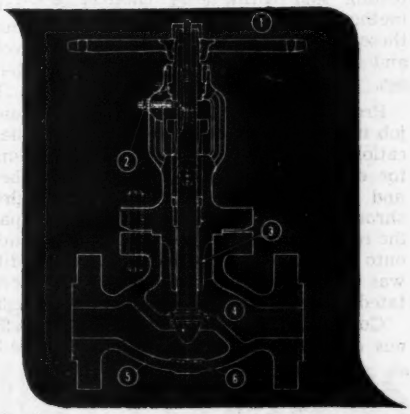
SOLUTION: Here is a valve with all the features that are important in throttling. An indicator **(1)** attached to the stem shows position of the disk at all times. An Alemite fitting **(2)** eases operation. A long stem guide **(3)** keeps the stem and disk in perfect alignment at all times. The seat **(4)** is a heavy layer of Stellite, applied directly to the valve body, and the disk **(5)** parabolic in design for volume control and integral with the stem, has Stellited seating faces, too. A bearing surface of EVinlay **(6)** on the valve body gives additional protection against high velocity flow. It is recommended that the valve be installed with pressure over the disk.



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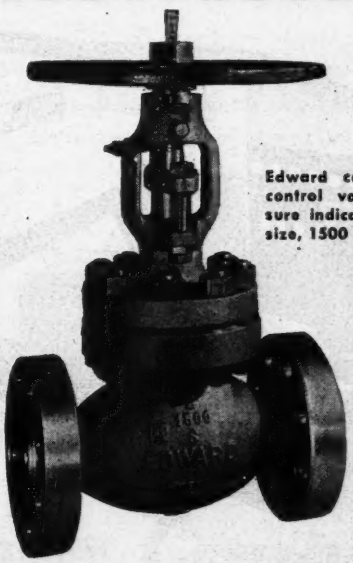

Edward cast steel flow control valve with closure indicator, in 2 inch size, 1500 lb ASA rating.

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good material for the rotors themselves. This set up a problem of attaching the steel stub shafts into the cast-iron rotors. A number of methods were studied, but the most advantageous from the point of design appeared to be low-temperature brazing, or silver soldering. This is a well-known process, used extensively on small parts, but little used on parts as large as these. As a result of tests, the brazing material was properly placed, a method of cleaning and fluxing the material was developed, and a heating cycle procedure set up which assured good silver-brazed joints.

In the manufacture of the regenerator, it was necessary to have a large number of joints which would transmit heat from the tubes to the fins. In this regenerator there was over 8½ miles of nickel tubing, the largest order of nickel tubing ever supplied. These joints had to be of such a type as to remain strong at a temperature exceeding 1000 F. With considerable testing and numerous changes a method was developed for building these regenerators from nickel tubing and sheets, by a copper brazing process.

Probably the most unusual welding job in the whole plant was the fabrication of the turbine rotors. The rotor disks were completely machined and the blades were attached and shrouded, prior to the assembly of the rotor. Then the disks were shrunk onto the stub shaft. Next the rotor was supported horizontally and rotated at welding speed.

Guards were put between the various disks to protect the blading and disks from weld spatter, and welding was carried out to a very set sequence laid out on a calendar and checked off as each weld was made. When welding was finished the rotor was removed from the frame and placed in a furnace in which it could be rotated at a slow speed and heated to 1400 F. This temperature was maintained for 16 hr and the rotor was allowed to cool. Some rough machining was then done on the rotor before it was returned to the furnace for heat indication.

Further Problems

With the present plant, reversal of rotation, important in marine application, will have to be done by the driving mechanism-electrical or mechanical- following the turbine. New forms of transmissions are being studied, however, and many developments are expected.

The plant is designed to burn high grade fuel oil, because of the high combustion rates required over a wide load range, but it has also operated satisfactorily with No. 5 fuel oil. To burn coal in this plant, however, involves solution of more difficult problems.

It is possible that with combustion under pressure, pulverized coal can be burned at high rates in relatively small combustion chambers. Ash must be eliminated from the combustion products ahead of the turbine or must pass through it. There are indications that these problems may be less difficult than anticipated. At all events, the economic advantages of coal burning are so great that every effort will be made to overcome the difficulties as rapidly as possible.

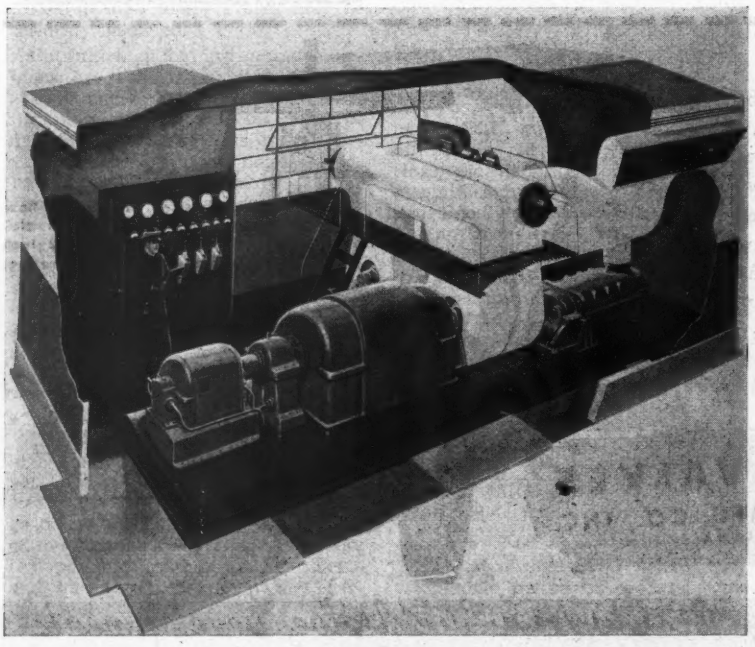

Fig. 6. Proposed industrial power application of the Elliott gas turbine power plant

Stoker Manufacturers Meet in Chicago

THE STOKER MANUFACTURING INDUSTRY held its first postwar conference in the form of the 28th annual meeting of the Stoker Manufacturers Association at the Stevens Hotel in Chicago on August 22 and 23 with over 100 representatives of stoker manufacturing and allied firms and guests in attendance.

The meeting was devoted largely to postwar plans of stoker manufacturers and to reconversion problems in the stoker industry. A complete national advertising and sales promotional campaign for the industry was presented and thoroughly discussed. While the program was not approved, the members of the Association are to study it carefully and further meetings will be held in the near future. The program features industry-wide national advertising campaign stressing the advantages of automatic stokers and automatic coal heat to the public.

Stoker manufacturers in general will be able to step up their production of domestic stokers gradually during the balance of this year and in 1946 production and sales may be on the highest level in the history of the industry. Some of the materials bottlenecks the industry has experienced since the fall of 1944 have been eliminated but the foundry situation at present is hampering the immediate prospects of a greatly accelerated production rate of domestic stokers.

New officers of the Association were elected for the ensuing year. Walter Sormane, Mendota, Ill., sales manager, Conco Engineering Works, was elected president succeeding John M. McClintock, Chicago, manager, stoker division, Illinois Iron and Bolt Co., who had served as president for four years. George W. Graham, Chicago, president, Eddy Stoker Corp., was elected vice president succeeding Mr. Sormane and Claude A. Potts, Lebanon, Ind., vice president, U. S. Machine Corp., was elected secretary-treasurer succeeding Mr. Graham. Marc G. Bluth, Chicago, was reappointed executive secretary.

Mr. Sormane, Mr. Graham and Mr. Potts were also elected to the board of directors with Mr. Sormane as chairman. Other members of the board elected were: C. T. Burg, Cleveland, Ohio, vice president—sales, Iron Fireman Manufacturing Co.; F. H. Herndon, Chicago, manager, stoker division, Link-Belt Company; J. M. McClintock; W. L. Schultz, Louisville, Ky., vice president, Anchor Stove and Range Co.; H. E. Sill, Muncie, Ind., vice president, Muncie Ind., vice-president, Muncie Gear Works, Inc., and Milton A. Young, Catskill, New York, sales manager, Catskill Metal Works. Mr. Young is also chairman of the Association's Anthracite Section.

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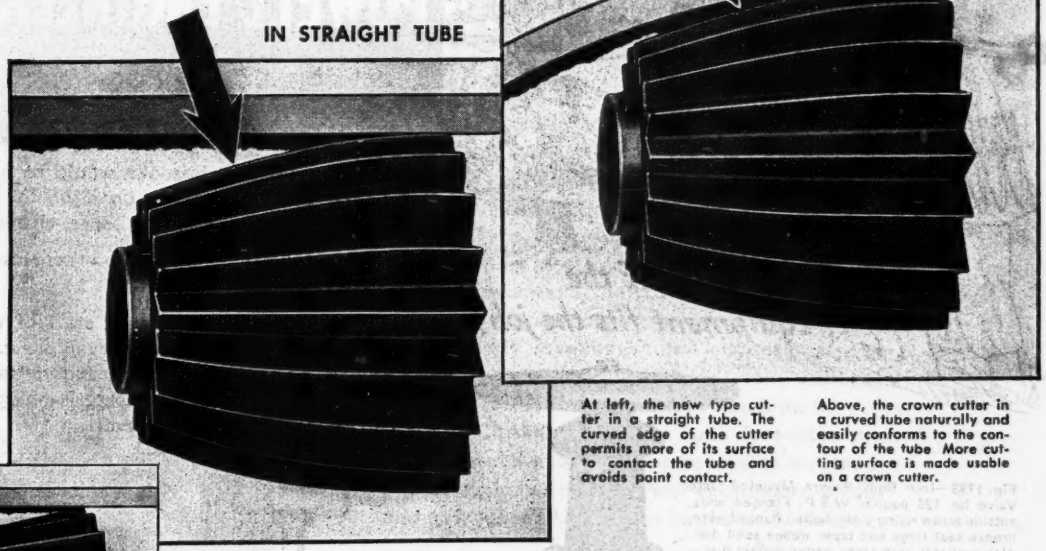
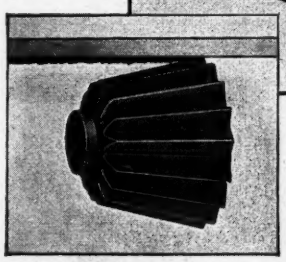


At left, the new type cutter in a straight tube. The curved edge of the cutter permits more of its surface to contact the tube and avoids point contact.

Above, the crown cutter in a curved tube naturally and easily conforms to the contour of the tube. More cutting surface is made usable on a crown cutter.



WITH FORMER DESIGN the sharp edge at the rear of the cutter was the only part to meet the tube wall.

Improved cutter design for

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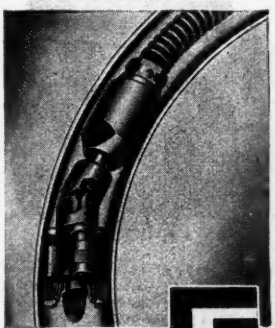
Rounding the teeth of front cutters removes all possibility of sharp corners scoring tubes, particularly in curved tubes. This cutter is now standard in all Elliott cutter heads using a 1 in. or larger cutter. Except for the rounded center section, the cutter is the same in dimension as the straight sided cutter formerly used, and will be supplied on orders for cutter replacements.



"TRACKLESS", TOO—cutter teeth are so spaced as to avoid striking the same point in repeated rotation inside the tube. At each revolution a tooth attacks a point slightly in advance of the former point, removing all deposit and preventing gear design in the tube. Another safeguard protecting tube inner surfaces.

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That's why Powell maintains a staff of valve engineers who are always at your service for consultation and advice. And if you have any individual flow control problems, Powell Engineering is ready to design the correct valves to meet them.

Fig. 1793—Iron Body Bronze Mounted Gate Valve for 125 pounds W.S.P. Flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available with taper wedge double disc—Fig. 1444.

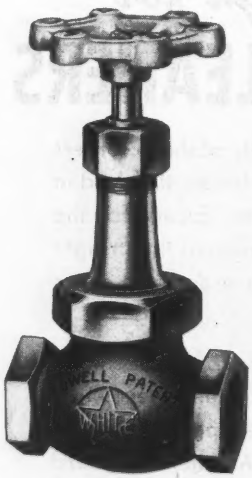

Fig. 1708—Bronze Globe Valve for 200 pounds W.S.P. Screwed ends, union bonnet, renewable seat and regrindable, renewable, wear-resisting "Powellium" nickel-bronze semi-cone, plug type disc.

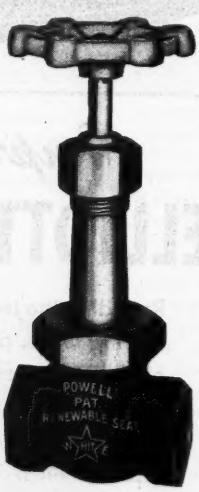

Fig. 1375—Bronze Gate Valve for 200 pounds W.S.P. Screwed ends, inside screw rising stem, union bonnet, renewable wear-resisting bronze seat rings and taper wedge solid or double disc.

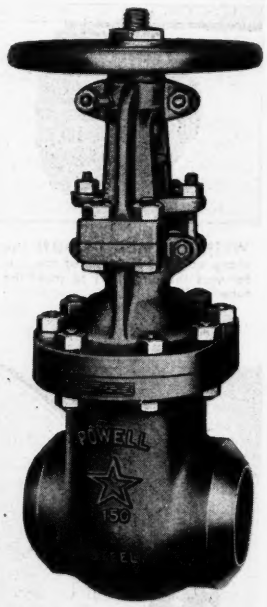

Fig. 1503 W. E.—Class 150 pound Cast Steel Gate Valve. Welding ends, outside screw rising stem and bolted flanged yoke.

The Wm. Powell Co.

Dependable Valves Since 1846

Cincinnati 22, Ohio

DISTRIBUTORS IN PRINCIPAL CITIES

POWELL VALVES

New LIFE TO OLD CONDENSER TUBES!

DON'T discard condenser tubes simply because of inlet end erosion or thinning! Worn tubes can be given a new lease on life *at a tremendous cost saving* with JOHN CRANE Condenser Tube Protectors.

These Tube Protectors are molded of a hard, thermo-setting plastic, more resistant to wear than the tube metal itself. They cover the damaged inlet end sections; absolutely prevent further erosion. The smoothly rounded Venturi entrance restores original hydraulic efficiency—in many installations efficiency has actually been increased.

JOHN CRANE Condenser Tube Protectors are easy to install and are being used with outstanding success on all types of heat exchangers, on old and new tubes. Also in use by the U. S. Navy.

Photo of eroded inlet ends before installing Condenser Tube Protectors

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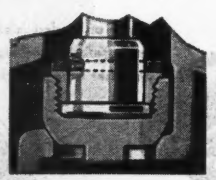
CRANE PACKING CO., LTD., Hamilton, Ontario, Canada.
Branches: Montreal, Toronto, Vancouver

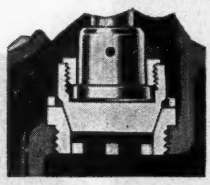
WHERE *Higher* QUALITY MEANS *Lower* ULTIMATE COST

● It's a matter of simple arithmetic. If one valve costs two-thirds more than another and lasts eight times as long in the same service—naturally it's a better buy. That is the principle on which this line of superlative bronze valves is engineered.

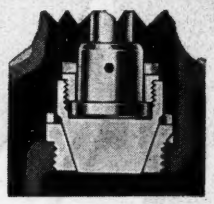
We suggest you send for this file-size folder of information about PRATT & CADY bronze globe and angle valves. The page on "Dollars and Sense of Valve Service" is worthwhile reading for anyone responsible for buying valves. Send for your copy of DH 1285.



Re-Grinding Type
for occasional throttling service



Semi-Plug Type
for frequent throttling service



Full-Plug Type
for severe throttling service

READING-PRATT & CADY

MANUFACTURERS OF
READING CAST STEEL VALVES AND FITTINGS • PRATT & CADY BRASS AND IRON VALVES
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AMERICAN CHAIN & CABLE

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WHICH SHOULD YOU USE?

ONE OF A SERIES OF ADVERTISEMENTS DESCRIBING THE MANY TYPES OF G-R HEAT TRANSFER APPARATUS

In some plants, the operating conditions, steam demands and quality of raw water make water treatment the logical method of maintaining a satisfactory boiler feed supply.

In other plants, these factors, together with the heat balance of the plant or the % makeup required, make an evaporator system advisable. The size of the plant may not be as determining a factor as the plant processes, and each case requires individual study.

Every plant engineer should give consideration to this important matter, because thorough analysis may develop unexpected possibilities of improvement in boiler operation and plant economy. You can obtain a thorough . . . and authoritative . . . analysis by consulting the Griscom-Russell engineers . . . specialists in heat transfer problems for more than 70 years.

If their study of your particular plant conditions shows that an evaporator installation is unnecessary, they will tell you so, frankly. If, on the other hand, worth while operating or economic advantages can be produced by distillation of boiler feed makeup, the unequalled experience of the Griscom-Russell engineers in developing and applying evaporator systems will assure you the most suitable type of installation for your needs. Your request for a plant survey will not involve the slightest obligation on your part. Write for complete information.

G-R BUILDS ALL THESE UNITS FOR HEAT TRANSFER SERVICE . . .

- Evaporators
- Stage Heaters
- Gas Coolers
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- Air Preheaters
- Fuel Oil Heaters
- Jacket Water Coolers
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THE GRISCOM-RUSSELL CO.
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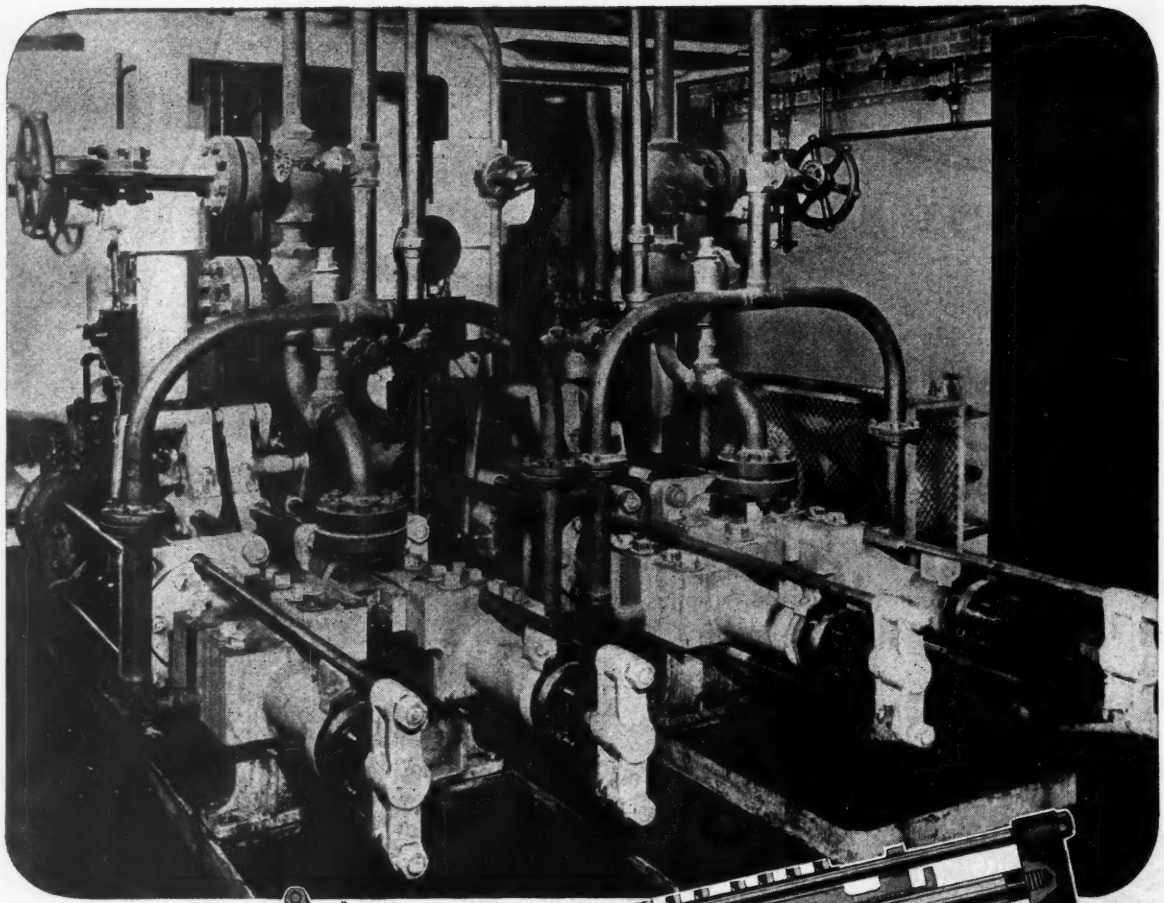
GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus



WARREN PUMPS

Help Solve a Desuperheating Problem

The problem was to obtain a very small variable quantity of water at a very high and constant pressure. Warren reciprocating steam pumps, with their easily controlled delivery, tolerance and pressure, furnished the solution.

In the installation shown above, steam supply varies between 1200 pounds and 900 pounds; between 615°F and 750°F. The load varies from zero to 18,000 pounds per hour.

The proper pressure and quantity of desuperheating water delivered by Warren Pumps permits the control equipment to function properly, and to maintain uniform downstream conditions of pressure and temperature at all times, irrespective of initial and load conditions.

These desuperheating pumps are located a mile away from the supervising engineers and have operated year in and year out with minimum attention and repairs. Send for descriptive folder on this type of Warren Pumps.

WARREN STEAM PUMP CO., INC.
WARREN, MASSACHUSETTS

What! Horse Collars Aboard Ships?

★ *To the ordinary landlubber this is only a queer looking piece of pipe; but to the marine engineer it is a Morison Type Corrugated Furnace, one end horse collar, other end plain. Such furnaces are a vital part of the compact, sturdy and efficient Scotch Marine Boilers that power so many small cargo vessels.*

For more than 30 years Taylor Forge has been the leading American maker of these fireboxes. Experience thus gained has added its share to our knowledge of how hot metal behaves —how to make it go where you want it to go.

YES, if you know how to make forging-temperature metal go where you want it to go, and in the right amounts, there are a lot of things you can do—and do *better*. Take Welding Fittings, for example, specifically welding elbows. You can have:

- Full pipe wall thickness at all points *plus* the right amount of reinforcement to provide full, uniform strength . . . as WeldELLS have.
- Tangents that help in lining up and keep the welds away from the zone of highest stress . . . as WeldELLS have.
- Perfect circle cross section for best flow conditions . . . as WeldELLS have.
- Finest metallurgical structure for greater strength . . . as WeldELLS have.

If you add such features as quarter-marked ends, permanent and complete identification marking, machine tool beveled ends, extreme dimensional accuracy, then you have fittings like WeldELLS: for indeed—

WeldELLS have everything

WeldELLS alone combine these features:

- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends**—simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P.O. Box 485
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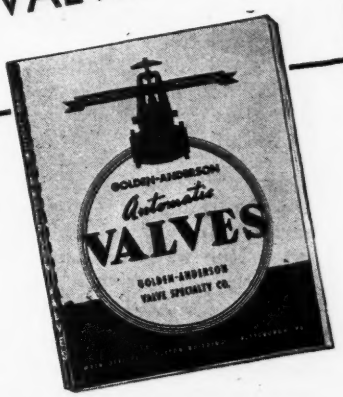
CORRUGATED PIPE
AND BENDS
ADAPTABLE • LESS STRESS • SAVED SPACE
In problems involving high forces or moments due to thermal expansion, Navco Corrugated Pipe and Bends are frequently the only solution.
By reducing the bending stresses and minimizing the end reactions, a safe design is insured which perhaps could not otherwise be obtained.
Whenever you have any unusual Piping problems, consult Navco.
NATIONAL VALVE & MFG. CO., PITTSBURGH, PA.
ATLANTA BOSTON BUFFALO CLEVELAND CHICAGO NEW YORK PHILADELPHIA
NAVCO
NAVCO PIPING

There's no chatter or spinning

WHEN YOU OPERATE THE GOLDEN-ANDERSON TRIPLE ACTING NON-RETURN VALVE!



Here is a valve that operates effectively . . . without banging, chatter or spinning . . . *under any flow conditions!* It's the "Double Corliss" dashpot assembly that does this cushioning job—and makes the GAVSCO Non-Return Valve reliable for any emergency. The design assures perfect alignment of moving parts and prevents galling or binding.

In operation the Non-Return Valve will:

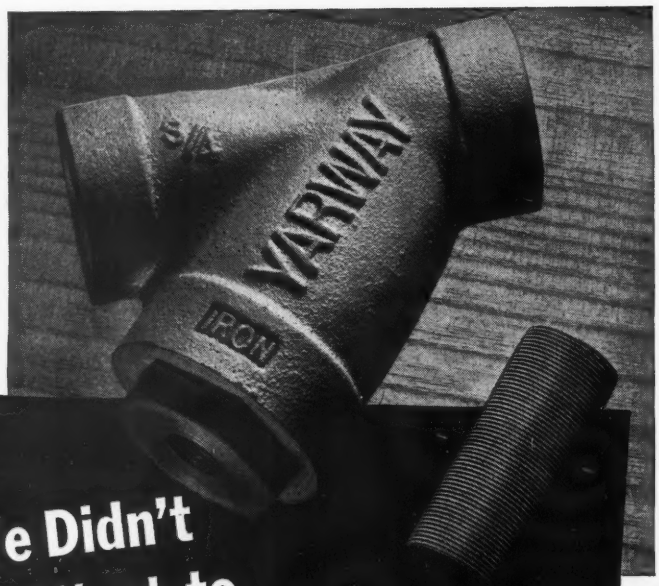
1. **Automatically cut in a boiler whenever its pressure equals line-header pressure.**
2. **Isolate a boiler automatically whenever its pressure, from any cause, is lower than line-header pressure.**
3. **Prevent steam flow from boiler in event of sudden drop of line-header pressure below the boiler pressure by means of differential shot pilot valve.**

Get this unfailing automatic life and property protection for *your* operations. The valve illustrated is a Toggle Yoke design, available in sizes from 2½" to 12", to handle 600 to 1500 lb. pressures. Other types we can supply include Angle, Globe, Elbow and Cross patterns.

This catalog contains illustrations and detailed descriptions of all GAVSCO Specialty Valves. Write for your copy today. Get acquainted with this complete line of automatic valves!

GOLDEN-ANDERSON
VALVE SPECIALTY CO.
FULTON BLDG. PITTSBURGH, PENN.

WORLD'S BEST AUTOMATIC Valves



We Didn't Want to Make Strainers

BUT we needed them for use with Yarway Steam Equipment and couldn't find any to suit us.

So we designed the *YARWAY Strainer.*

Apparently a lot of other people were having "Strainer trouble" because, without a line of advertising, the Yarway Strainers *purchased* in a few years now number *many thousands.*

Why don't you look into this better Strainer for your money? Buy one from your supply house (over 100 Mill Supply Houses now have them).

See its protection against corrosion—*cadmium plating inside and out.*

Examine its *high grade Monel woven wire screen* that stops dirt—lets condensate or other fluids flow freely.

Notice the removeable blow-off bushing. Screen and bushing come out together—go back together, *automatically aligning.*

Six standard sizes from ½" to 2" for pressures to 600 lb.

See your Mill Supply House or write for Bulletin S-200

YARNALL-WARING COMPANY
114 Mermaid Ave. PHILADELPHIA 18, PA.

YARWAY STRAINERS

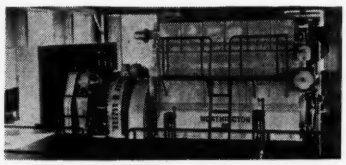
NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. Write to POWER PLANT ENGINEERING 53 W. Jackson Blvd., Chicago 4, Ill.

Rectox Units for Engine Ignition

RECTOX RECTIFIER units built by Westinghouse are used for primary ignition current on each one of the 58 compressor engines employed on the new 24-in., high pressure gas line from Corpus Christi, Texas, to Cornwell, W. Va.

Engine ignition is direct current, impulse type, with individual induction coils for each spark plug. Instead of the conventional magneto source of power to the ignition coils, a Rectox rectifier is used. The primary supply is 440 v, 3 phase, 60 cycle; and the output is 10-14v, 2 to 4 amp, d-c, sufficient to supply ignition demands of all engines. Each Rectox unit is equipped with voltmeter, ammeter, circuit breaker and rheostat. There are no batteries in the ignition circuit.



The use of the Rectox unit provides a fool-proof interlock between the main line compressor engines, the water circulating pumps and the station service generators. If the station service generators fail for any reason, the resulting loss of electric power stops the circulating pumps which cool the compressor engines. Since the compressor engine ignition system also shuts down on electric power failure, the compressors are stopped at the same time as the circulating water pumps go out, thus making it impossible for the main engines to overheat by running after failure of the cooling water system.

Another advantage of this application of the Rectox unit is that each machine is independent of all others. The entire station cannot be shut down through the failure of an element of the ignition supply.

Photoelectric Smoke Detector

A PHOTOELECTRIC system now available from Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass., detects the presence of smoke in air conditioning ducts and immediately sounds alarms, turns off blowers, operates automatic dampers, or provides whatever other type of indication or control is required.

The system consists of Photoelectric Control Type A26X and Light Source Type L11RX. The latter may be mounted to project a beam of light over any distance from 10 to 25 ft, to the "eye" of the photoelectric unit. A sensitivity adjustment on the light

"Trifles make perfection but perfection is no trifle"

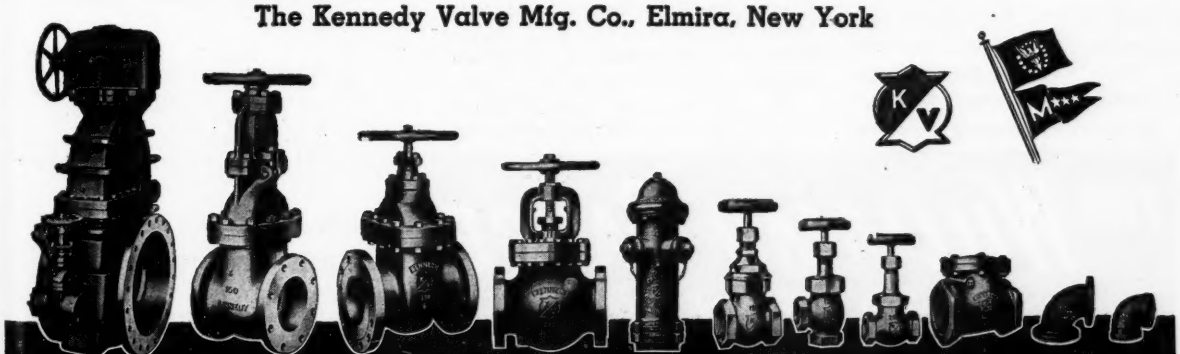
One of a series of advertisements explaining how Kennedy gives careful attention to the details of valve design, construction and workmanship that provide maximum effectiveness, convenience, and length of service.

The "third degree"

that every KENNEDY valve must endure

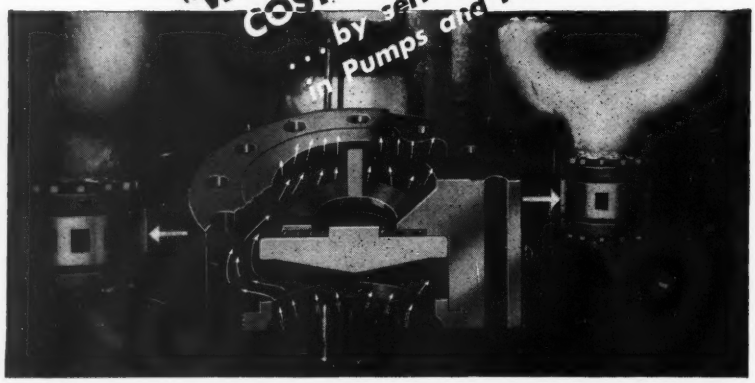
When the Kennedy Tester finishes with a valve, he knows—and knows definitely—whether or not it is perfect in every respect. His cross examination is thorough and relentless. It covers every detail of the valve from flange faces or hex threads to handwheel; and is sure to uncover any flaw that may exist in metal, joints, or mechanism. His sole job is to detect imperfections and he is entirely independent of the Production Department. That is why you can be sure that every Kennedy Valve . . . Iron Body or Bronze . . . Gate, Globe, Angle, or Check . . . has actually proven that it will withstand far more than its rated pressure, will seat tight, release promptly, and operate dependably.

The Kennedy Valve Mfg. Co., Elmira, New York



KENNEDY *valves . . . pipe fittings . . . fire hydrants*

"WATER HAMMER" COSTS YOU MONEY!
. . . by serious breakdowns in Pumps and Piping Systems



WILLIAMS-HAGER FLANGED Silent CHECK VALVES

Precision Engineered to Eliminate "HAMMER and BANG" in ANY system with Operating Pressures up to 6,000 lbs.

Heavy duty service records upwards of 17 years without removal from lines . . . Williams-Hager Flanged Silent Check Valves are built to meet the exacting requirements of any end use. No webs to restrict or hamper the flow of liquids . . . the free-floating valve will operate normally and efficiently in *any* position.

Dependably constructed in sizes from 1" to 20" inclusive, from iron, semi-steel, bronze, cast steel, stainless steel or monel . . . pressure resistant to 6,000 pounds.

Do you have the new Williams Catalog for Power Plant Equipment?

specified by Leading Industries for such exacting uses as:

Public Utilities • Water Works • Industrials • Oil Refineries • Paper Mills • Hotels • Hospitals • Chemical Works • Office Buildings • Public Buildings • Breweries • Steamship Lines, etc.

THE WILLIAMS GAUGE COMPANY

Pump Valves . . . Water Gauges . . . Gauge Cocks . . . Pump Governors . . . Steam Traps Feed Water Regulators . . . Water Columns

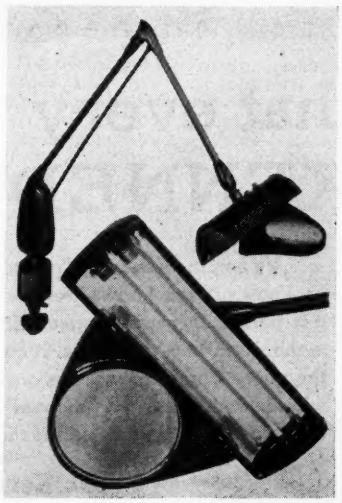
3000 PENNSYLVANIA AVENUE • PITTSBURGH 12, PA.

source housing permits variation in the intensity of the light beam and may be set so that the photoelectric control will respond to smoke of a predetermined density. Type A26X will then remain inoperative at any other level of illumination, but will be actuated when smoke haze sufficiently reduces the amount of light reaching the phototube. To provide complete protection, Type A26X is so designed that either current or tube failure will cause the control to operate as though the light beam were interrupted.

Type A26X operates from a supply of 115-V a-c 60 cycles and incorporates a single-pole double-throw relay for normally open or normally closed operation. Relay contacts are pure silver, designed to handle 10 amp a-c or 5 amp d-c at 115-v. When using external power, a maximum of 230-v may be used on the contacts providing 1100-w a-c or 550-w d-c is not exceeded. Larger currents or higher voltages can be controlled through use of an auxiliary power relay.

Fluorescent Light

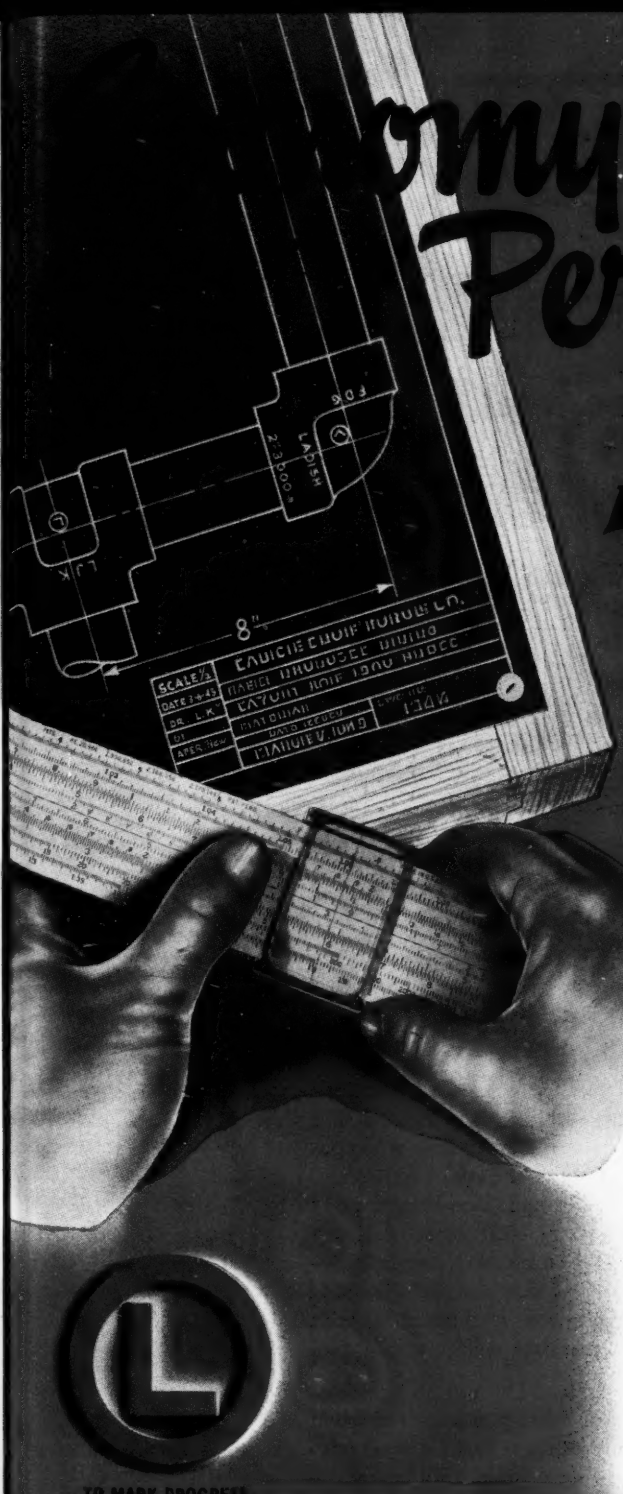
AN ADAPTATION of Super Sight (magnification) to fluorescent lighting has been announced by Boyer-Campbell Co., 6540 St. Antoine St., Detroit 2, Mich. Manufactured en-unit with the fluorescent lamp, Super Sight (magnifying lens) and light assembly are mounted on a balanced bracket that can be instantly placed in any position over a wide work area.



Super Sight is now supplied in 3 types of lighting: 1. Standard bayonet type of bulbs; 2. Lamps that are sealed to relieve the explosion hazard; 3. Fluorescent lamps. It is also supplied with 3 types of brackets and 2 sizes of lenses.

Low Range Limits Bridge

MODEL 81 LOW RANGE LIMITS BRIDGE, manufactured by Associated Research, Inc., 231 S. Green St., Chicago 7, Ill., is one of a series of units for the rapid comparison of large quantities of resistors having comparable values. It is admirably adapted to volume testing of resistance



...omy MEASURED BY Performance

Proves the Added Value of LADISH Forged Steel Fittings

The added strength and safety afforded by Ladish forged steel fittings assure ultimate economy in years of trouble-free operation and freedom from costly piping failures.

Maximum strength, endurance and safety are assured by the authentic symbol of Controlled Quality, the Ladish Heat Code.

REASONS WHY

1 Forged — **Fittings resist strains of expansion and contraction from temperature ranges.**

2 Forged — **Fittings withstand greater fatigue strains caused by vibration.**

3 Forged — **Fittings have greater resistance to hydraulic shock pressures.**

4 Forged — **Fittings eliminate possibility of failure due to concealed defects.**

5 Forged — **Fittings produced under Controlled Quality possess better properties for assured weldability.**

TO MARK PROGRESS

ARMY-NAVY "E" AWARD

FITTINGS DIVISION

LADISH DROP FORGE CO.

CUDAHY • WISCONSIN (MILWAUKEE SUBURB)

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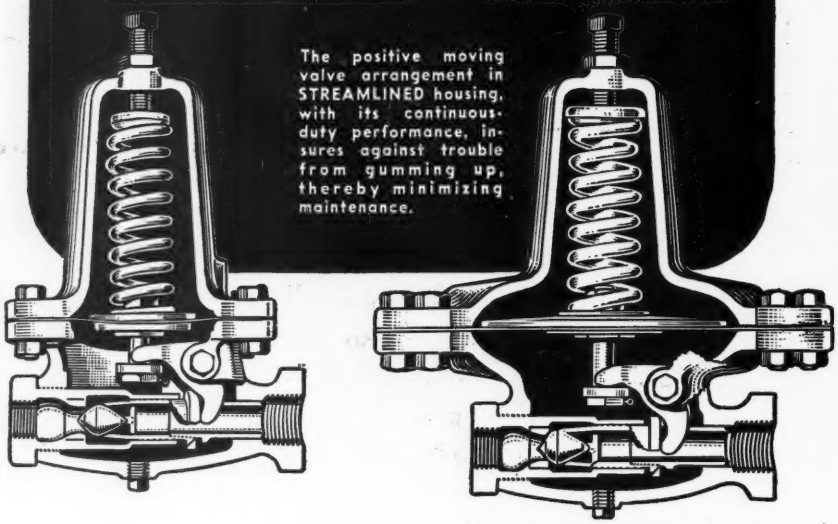
CASH STANDARD Streamlined TYPE 1000 PRESSURE REDUCING VALVES


The positive moving valve arrangement in STREAMLINED housing, with its continuous-duty performance, insures against trouble from gumming up, thereby minimizing maintenance.

THIS STRAIGHT LINE FLOW an Important Aid to CONTINUOUS PROCESSING

Write today for Bulletin 1000—it describes and pictures how, from inlet to outlet the fluid flows through this valve in a straight line—a streamline. Steam, air, and water capacity charts are shown. Eight pages of valuable valve facts.

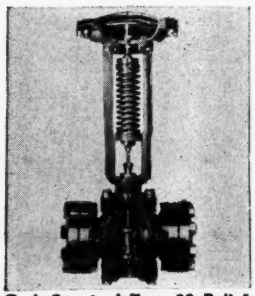
WHETHER your type of processing is continuous or batchwise, the "1000" Streamlined CASH STANDARD pressure reducing valve will contribute effectively to greatest overall efficiency. This is so because the Straight Line Flow insures —(1) maximum capacity—(2) close delivery pressure control—(3) accurate regulation—(4) tight closure. All of this results in smooth operation and continuous performance with practically no maintenance over periods that extend into years.

This accurate, reliable pressure reduction service for steam, air, oil — in fact for most anything that flows — is well worth your investigation so that you will know just how effectively and extensively the "1000" will benefit your entire process.

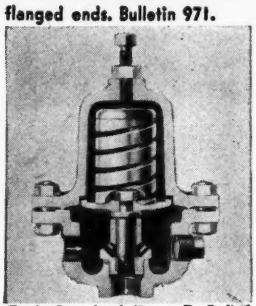
CASH STANDARD CONTROLS.. VALVES

A. W. CASH COMPANY
DECATUR, ILLINOIS

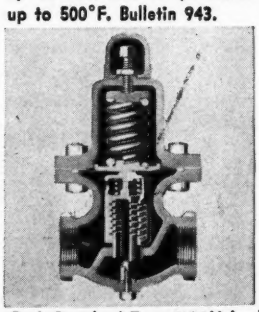
OTHER VALVES from the CASH STANDARD LINE



Cash Standard Type 33 Relief Valve; in various metals to handle nearly all fluids. Has Roller guides on valve spindle; also roller bearing to take care of spring torsion. Sizes ½" to 3" screwed ends; 1" to 12" flanged ends. Bulletin 971.



Cash Standard Type Q Relief Valve has side inlet, bottom outlet. Popular for pump by-pass use. Sizes ½" to 2" screwed ends. Relief pressures up to 350 lbs., temperatures up to 500°F. Bulletin 943.

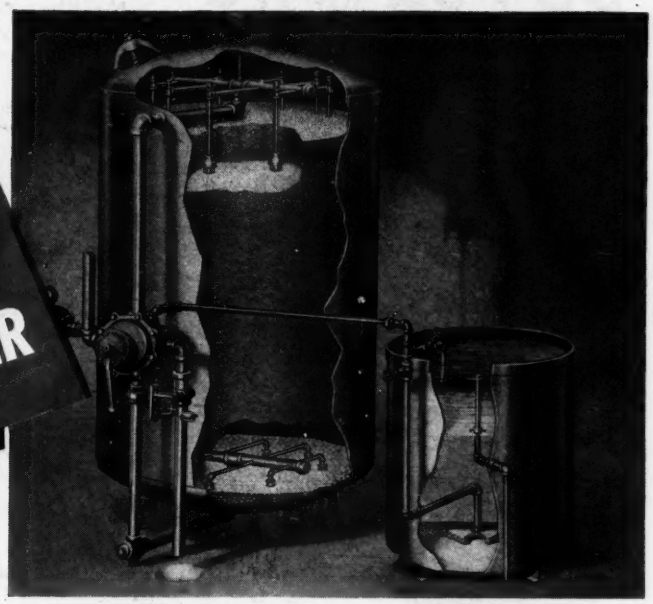


Cash Standard Type 4190 Valve for relief (bypass) use; holds constant valve inlet pressure regardless of changes in load or outlet pressure. Multiport—large capacity. Iron or bronze bodies; iron or bronze trim. Sizes ½" to 2" screwed ends; 2" to 6" flanged ends. Bulletin 952.

NOW AVAILABLE

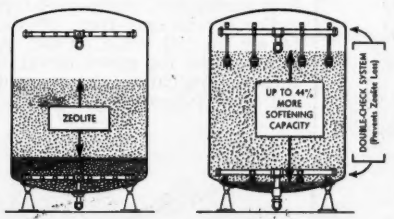
postwar design

ELGIN WATER SOFTENER



. . . delivers up to 44% more soft water

NOTE THE INCREASED CAPACITY



ORDINARY WATER SOFTENER DESIGN

ELGIN WATER SOFTENER DESIGN

HERE'S HOW TO STEP UP THE OUTPUT OF YOUR PRESENT WATER SOFTENER

The "Double-Check" equipment can be installed in place of the present manifold in your zeolite softener regardless of make. This change, along with Elgin High Capacity Zeolite, will give you greatly increased soft water output. The cost of this modernization is surprisingly low. Let us give you facts.

• Here's real news for users of zeolite water softener equipment. Our postwar design is now available. It delivers up to 44% more soft water than any other unit of equal size. Of importance is the fact that this new water softener has been fully proved by gratifying results in a long list of plants where it is already in service.

An improved double-check type manifold prevents the escape of zeolite and therefore permits placing a far greater amount of water softening zeolite in the softener, as shown. More zeolite means more soft water output—for it's the zeolite that does the softening.

But that isn't all. A higher backwashing rate is also made possible by preventing loss of zeolite. This higher rate cleans the softener thoroughly. With the zeolite bed clean, the salt reaches every grain of zeolite. The result is better regeneration with less salt consumption . . . higher over-all efficiency.

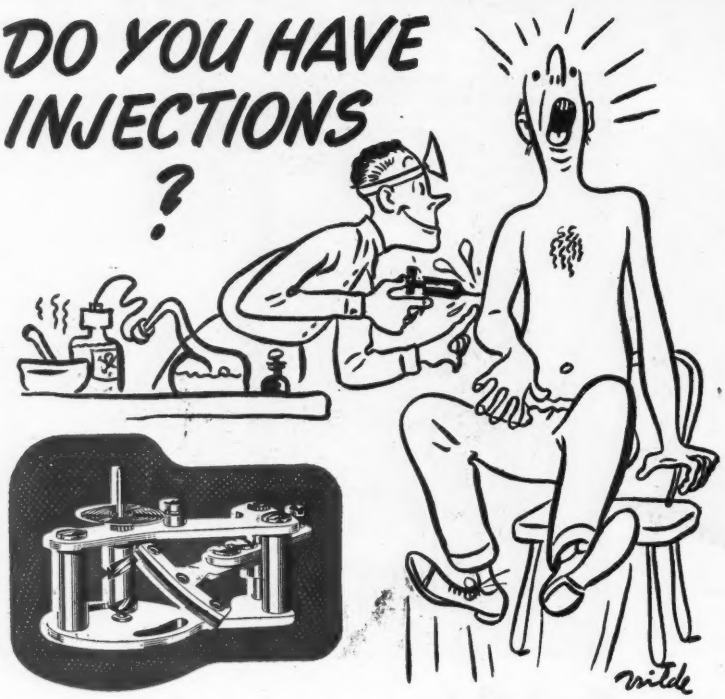
The whole story of tomorrow's water softener today is told in brand new bulletin 606. Write for your copy today.

ELGIN *economical water conditioning*

The complete Elgin line—Boiler Water Treating and Purifying Systems • Feedwater Treatment • Deconcentrators • Heat Exchangers • Water Softeners • Filters and Purifiers • Iron Removal Equipment • Aerators • Water Treating Chemicals • Chemical Feeders • Scale and Corrosion Inhibitors • Sample Coolers • Water Testing Equipment • Zeolites

ELGIN SOFTENER CORPORATION, 136 NORTH GROVE AVENUE, ELGIN, ILLINOIS

DO YOU HAVE INJECTIONS ?



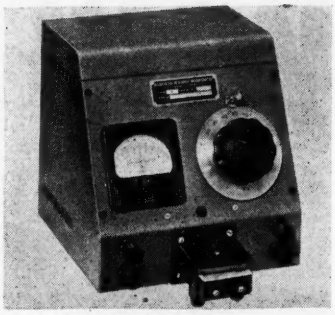
WE hope you never have injections like injection molding machines. They get injections so rapidly and under such high pressures that the shocks are terrific. These machines for molding plastics require pressure gauges. Ordinary gauges made with spur geared movements can't take this punishment — they are wrecked in no time at all by the sudden and violent pressure fluctuations. But Certified Gauges can take it. Only Certified Gauges with the Helicoid movement stand up under such severe service.

This is only one typical example of how Certified Gauges are cutting down maintenance expense in industry. Most every plant has pressure gauge trouble — brief service life, frequent repairs, inaccurate indications. The answer to such trouble has been found by all those companies now standardizing on Certified Gauges.

See your nearest Distributor.

Certified GAUGE AND INSTRUMENT CORP.

24-18 Northern Boulevard — Long Island City 1, New York



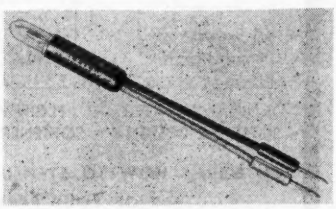
values up to 2000 pieces an hr, particularly for testing motor windings, transformer primaries or secondaries, rheostats, potentiometers, lamps, shunts or multiplier resistors, any item that offers ohmic resistance to flow of current.

Extreme flexibility through use of an external reference standard is one of the outstanding features of the instrument. A combination test fixture and automatic control switch adds to this characteristic; also binding posts at the right side of the unit for connection to user's test fixture where desired. Left hand binding posts are for connection of reference standard which can be supplied if desired.

This bridge is battery-operated. The overall adjustable range is from ¼ ohm to 10,000 ohms, with adjustable ratio arm, sensitivity control, production type test fixture with an automatic on-off switch. The indicator is a sensitive zero center galvonometer. The unit, self-contained, measures 8 by 8 by 12 in. and weighs 18 lb.

Pocket Circuit Tester

AN ALL-PURPOSE circuit tester has been made available by Amerline, 1753 N. Honore St., Chicago 22, Ill. It is convenient, vest-pocket type, and indicates voltages from 90 d-c, and 60 a-c, to 500 v a-c or d-c. A neon lamp on the top glows in varying intensities indicating circuit conditions. No glow indicates a dead line. The



lamp lights on currents as low as one microampere.

The new tester is used for locating blown fuses, trouble-shooting in cords and appliances such as electric irons and toasters, testing radio frequency, receivers, plate circuits and screen grids; for testing spark plugs, meters, condensers and armatures.

Electronic Recorders

INCREASED industrial use of electronic recorders has been made possible by stepping up chart speeds of Electronik Pyro-Potentiometers, according to Brown Instrument Co.

The standard speed electronic recorder, single or multiple point models, incorporate gear changes for

New COMPLETE *Catalog*

One DEPENDABLE *Source*

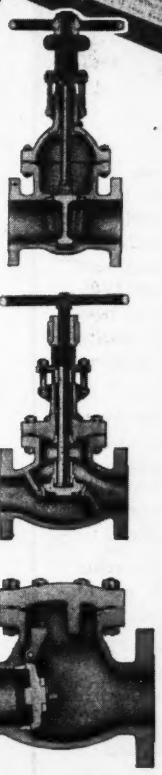
SEND FOR IT *Now!*

OIC

GATE

GLOBE AND ANGLE

SWING CHECK



This CATALOG IS DIFFERENT

THE NEW 1945 Edition of the OIC Steel Valve Catalog *tells all* on Steel Valves . . . gives you complete technical information in concise, time-saving form. Helps you to find quickly the *right* OIC Valve for every application and the correct trim to insure the best performance.

Forty-four pages packed with useful, authoritative data for every user of steel valves. You will find, listed and described, *complete* valve service from *one* dependable source backed by 62 years of experience and seasoned judgment in quality valve manufacture.

WRITE TODAY for copy of the new OIC Steel Valve Catalog. There is no obligation.

THE OHIO INJECTOR COMPANY

WADSWORTH, OHIO

Quality Leaders in Valve Manufacture Since 1883

DON'T TAKE IT FOR GRANTED THAT YOU CAN'T STOP CORROSION IN YOUR STEAM SYSTEM

LINES CORAVOL BOILER *Does it for you - -*

QUICKLY *and* EFFECTIVELY

CORAVOL ASSURES THIS

CORAVOL ELIMINATES THIS

CORAVOL IS PART OF A COMPLETE TECHNICAL SERVICE WHICH PROVIDES SPECIAL FORMULAS OF TREATMENT FOR:

Boiler Feed Water . . .
Hot Water Supply . . .
Refrigerating Brine . . .
Cooling and Condenser Water . . . Rapid Scale Removal . . . Coagulation . . . Algae Control

MAIL TODAY

The use of **CORAVOL** saves you costly pipe repairs, replacements, maintenance labor, hours and days of shutdown loss. **CORAVOL** (1) *prevents corrosion* in steam and condensate lines, (2) *cleans out* clogging rust deposits already present. Thus, **CORAVOL** *protects lines;* increases effectiveness of heat transfer surfaces; restores original capacity of lines and the operating efficiency of valves and traps.

CORAVOL is NOT a boiler feed water treatment. It is designed expressly for use in steam systems. Because **CORAVOL** volatilizes and condenses with the steam, it circulates throughout your entire steam system and protects *all* zones from corrosive attack.

For 8 years, **CORAVOL** has proved its value in hundreds of heating and steam power plants in more than 20 different industries.

Mail the coupon TODAY for complete FREE data about the **CORAVOL** process.

WESTERN CHEMICAL COMPANY
715 Washington Street — Kansas City 6, Missouri

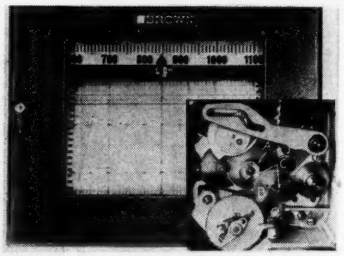
Without obligation to me, please send complete data on the CORAVOL Process

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY AND STATE _____ (3)



speeds of 5, 10, 15 and 20 in. an hr, it was said at the Philadelphia division of Minneapolis-Honeywell Regulator Co.

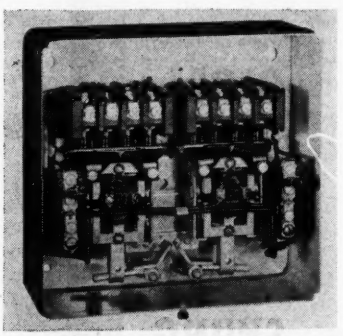
Fast speed electronic models, single or multiple point, will have internally mounted gears for speeds of 10, 20, 30 and 40 in. an hr.

As shown in the accompanying illustration, the gears are changed by removing screw "C" from gears "A" and "B" and by lifting the gears from the assembly. The new speed gears are then installed and screw "C" is replaced.

Mechanical Interlock Featured in New Starter

A NEW a-c magnetic reversing starter, featuring a semi-interference-type mechanical interlock, has been announced by the General Electric Co., Schenectady 5, N. Y. Available in sizes 0 and 1, the new starter is designed for full voltage starting of squirrel-cage induction motors, although it can easily be used for reversing service when combined with a reduced voltage starter.

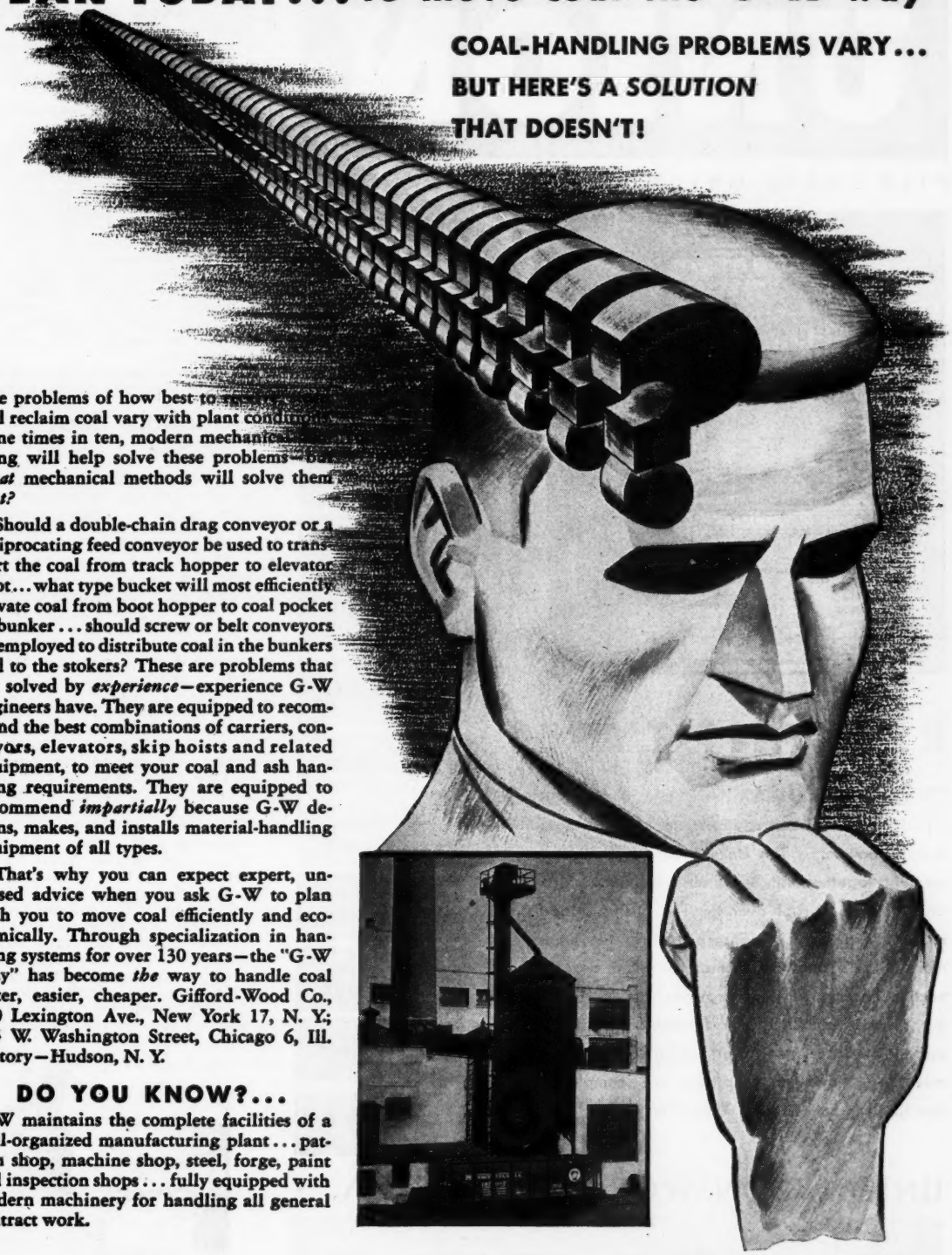
This mechanical interlock prevents the closing of one contactor while an arc is maintained on the other, thus averting a short circuit through the arc and the resultant burned contacts and blown fuses. In addition, the interlock arm of the closing contactor assists the interlock arm of the opening contactor in reaching its fully opened position. These interlock arms are case-hardened and their underside faces are buffed and polished to provide long life.



Other features incorporated in this starter are under voltage protection when used with a push-button station or other momentary pilot-circuit device; undervoltage release when used with selector or limit switches; and tamperproof, self-contained overload relays which allow the motor to operate up to its maximum safe temperature before tripping it off the line.

PLAN TODAY... to move coal the G-W way

COAL-HANDLING PROBLEMS VARY... BUT HERE'S A *SOLUTION* THAT DOESN'T!



The problems of how best to [illegible] and reclaim coal vary with plant conditions. Nine times in ten, modern mechanical handling will help solve these problems—but *what* mechanical methods will solve them *best?*

Should a double-chain drag conveyor or a reciprocating feed conveyor be used to transport the coal from track hopper to elevator boot... what type bucket will most efficiently elevate coal from boot hopper to coal pocket or bunker... should screw or belt conveyors be employed to distribute coal in the bunkers and to the stokers? These are problems that are solved by *experience*—experience G-W engineers have. They are equipped to recommend the best combinations of carriers, conveyors, elevators, skip hoists and related equipment, to meet your coal and ash handling requirements. They are equipped to recommend *impartially* because G-W designs, makes, and installs material-handling equipment of all types.

That's why you can expect expert, unbiased advice when you ask G-W to plan with you to move coal efficiently and economically. Through specialization in handling systems for over 130 years—the "G-W Way" has become *the* way to handle coal faster, easier, cheaper. Gifford-Wood Co., 420 Lexington Ave., New York 17, N. Y.; 565 W. Washington Street, Chicago 6, Ill. Factory—Hudson, N. Y.

DO YOU KNOW?...

G-W maintains the complete facilities of a well-organized manufacturing plant... pattern shop, machine shop, steel, forge, paint and inspection shops... fully equipped with modern machinery for handling all general contract work.

GIFFORD-WOOD

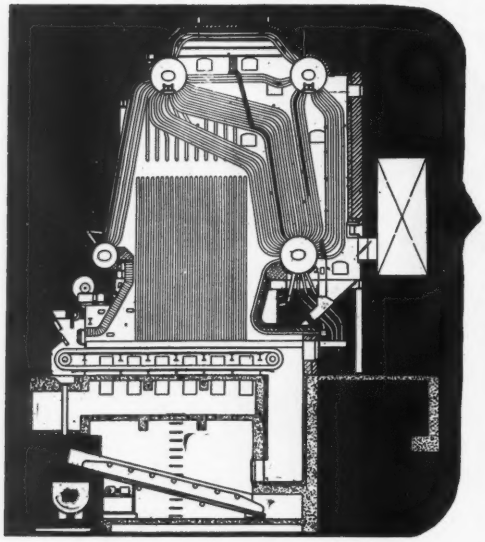
SINCE 1814

G-W HANDLES IT
Faster · Easier · Cheaper

379

UNION

FILE THESE UNION ADS FOR REFERENCE



H-TYPE
A-TYPE
RADIANT TYPE
L-TYPE
4-DRUM
O-TYPE
LONG DRUM
CROSS-DRUM
UNIVERSAL STEEL-CASED
UNIVERSAL BRICK-SETTING
HORIZONTAL RETURN TUBE
LITTLE GIANT
HEATING

RADIANT TYPE

THIS is a patented 4-drum boiler design that doubles the usual radiant exposure found in 4-drum boilers. This Union front wall radiant element, together with the main tube bank, form an "A" shaped roof over the fire. This added radiant exposure, by absorbing fully ten times more B.T.U.'s per sq. ft. than the blind or convection heating surface, provides faster steaming, greater capacity, lower furnace temperatures and maintenance, and lower setting costs. These advantages and many others are completely described in Bulletin RB. Write for copy.

UNION IRON WORKS ★ ERIE, PA. ★

BOILERS

PRESSURE VESSELS • PLATE FABRICATION

Mechanical Packing

A COMPLETE LINE of mechanical packing, made by a new method called the Lubraloy Process, has been placed on the market by the Flexrock Co., 3623 Filbert St., Philadelphia 4, Pa.

The outstanding features claimed for this packing are that it is self-lubricating and self-forming. The self-lubricating feature is obtained through an alloy structure of anti-fraction metals, which, by a special process, is impregnated with heat-resisting, lasting lubricants which cannot be driven off by heat or pressure and are emitted constantly.

Because it is ductile and self-forming the packing molds itself easily to the size and shape of stuffing-box, creating a seal, yet allowing rods or pistons to operate with a minimum of friction.

The new packing is available in suitable form for every packing use.

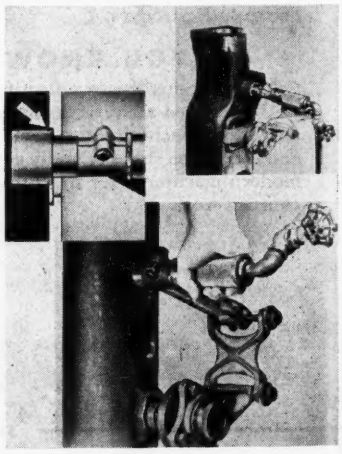
Handhole Seat Grinder

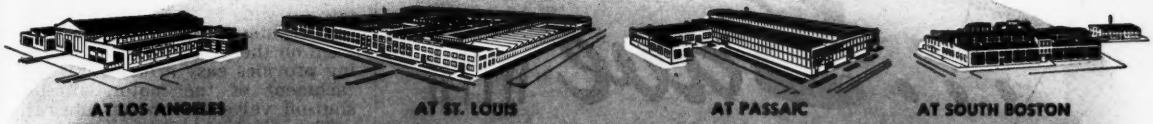
AN AUTOMATIC HANDHOLE seat grinder for use in marine and stationary boiler rooms is announced by the Lagonda Division of Elliott Co., Springfield, Ohio.

The new handhole seat grinder provides an easy, fast, accurate means of refacing handholes of all sizes and shapes through a grinding wheel properly alined with respect to the gasket seat by means of four screws in an adjusting plate. These assure grinding only in the plane of the gasket seat.

In addition to the grinding wheel, which is mounted on a ball bearing spindle, the assembly consists of a clevis arm, the adjusting plate, and a face plate screwed onto a handhole plate stud near the hole to be refaced. The amount of grinding is accurately controlled by a very finely threaded feed screw. The grinding wheels are double faced for longer service.

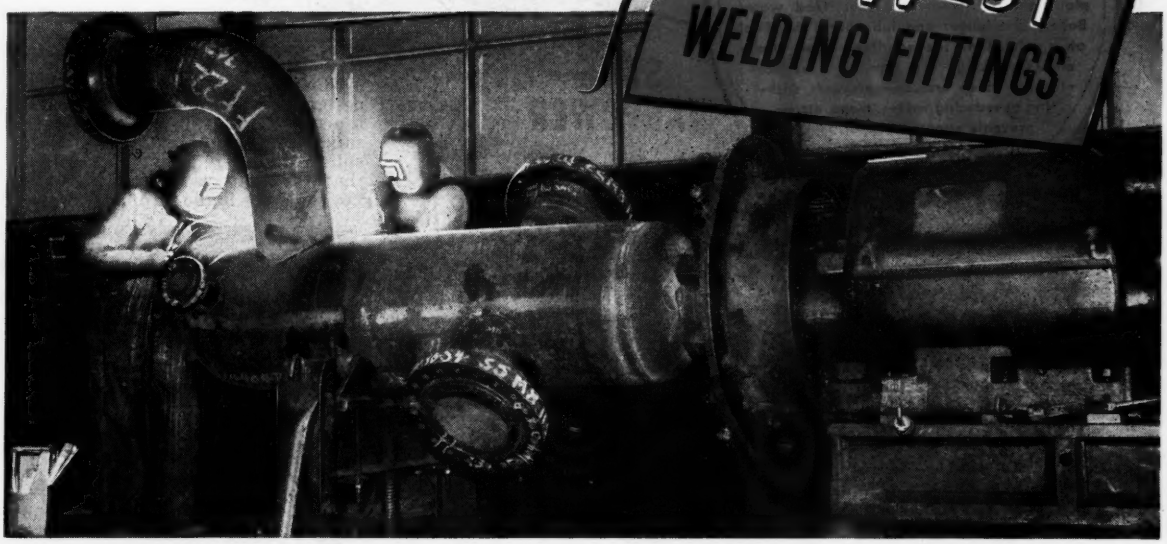
The clevis arm provides for free movement of the spindle around the handhole. Any handhole within reach of the grinder can thus be ground from a single position of the face plate, since the spindle arm is movable from one handhole to another. A high speed compressed air motor such as is used for operating Elliott





AT LOS ANGELES AT ST. LOUIS AT PASSAIC AT SOUTH BOSTON

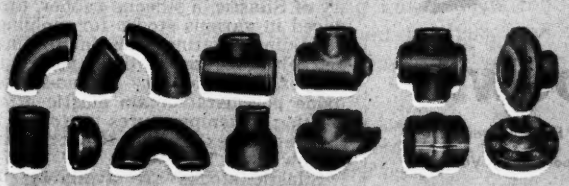
MIDWEST PIPE FABRICATING PLANTS Make a CONTINUOUS CHECK on the HIGH QUALITY of MIDWEST WELDING FITTINGS



Four modern Midwest pipe fabricating plants supply piping for all purposes and pressures to a great variety of industries from coast to coast. These Midwest plants are large users of Midwest Welding Fittings. This regular everyday use of these fittings in fabricating both simple and complex piping subassemblies provides an accurate and continuous check of their quality . . . of correct dimensions . . . of uniformity . . . of accurate angularity, etc.

But this daily use in our own fabricating plants does more than check quality . . . it makes certain that Midwest Fittings are thoroughly practical . . . that they meet the needs of modern piping practices from a design standpoint . . . that they are easy to lay out and weld. For example: the accuracy of Midwest machining methods makes it possible for the user to cut his pipe before receiving his Midwest Welding Fittings . . . he can depend upon the catalog dimensions. Buyers of Midwest Welding Fittings get the benefit of this unique situation. We sell you the same fittings we use . . . assuring you of quality fittings that are correctly designed and that save time and money on many different kinds of piping jobs. Bulletin WF-41 gives all the facts; ask for a copy.

MIDWEST WELDING FITTINGS IMPROVE DESIGN AND REDUCE PIPING COSTS



MIDWEST

PIPING & SUPPLY COMPANY, Inc.

Main Offices: 1450 South Second St., St. Louis 4, Mo.

Sales Offices: New York 7—30 Church St. • Chicago 3—645 Marquette Bldg. • Los Angeles 33—520 Anderson St. • Houston 2—229 Shell Bldg. • Tulsa 3—533 Mayo Bldg. • Atlanta 3—Red Rock Bldg. • South Boston 27—426 First St. • Distributors in Many Cities

. . . Save WITH HENSZEY CONTINUOUS BLOWDOWN

SAVE EQUIPMENT

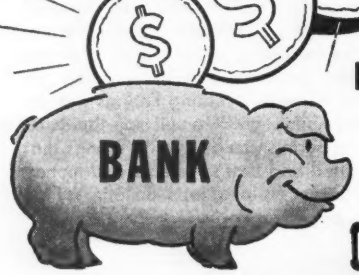
The Henszey Blowdown System prevents priming, foaming and carryover . . . and also prevents the formation of scale by simple chemical treatment of the feed water. Boilers last longer and tube burns are kept at a minimum. The resultant clean steam makes packings last longer — reduces turbine blade erosion—prevents sticking of reducing valves, traps, etc.— prevents superheater burnouts.

SAVE MANPOWER

The Henszey System is completely automatic. Boiler shutdowns and repairs are reduced to a minimum. No man hours lost unnecessarily replacing packings, repairing or replacing rods and cylinder rings, turbine nozzles, turbine blades, valves and other equipment along the line.

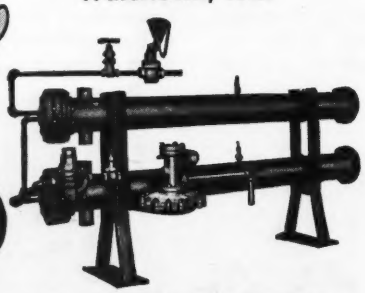
SAVE FUEL

The Henszey System offers complete, automatic blowdown without heat loss—a big fuel saving in itself. Then, too, boilers free from scale and sludge are more efficient — they require less fuel to produce the power load.



Plan now for postwar needs — send for details.

HENSZEY CO.
Dept. C9
Watertown, Wis.



HENSZEY

CONTINUOUS BLOWDOWN

Flow Indicators • Distillation System • Heat Exchangers
Feed Water Meters • Boiler Feed Regulators • Proportioning Valves

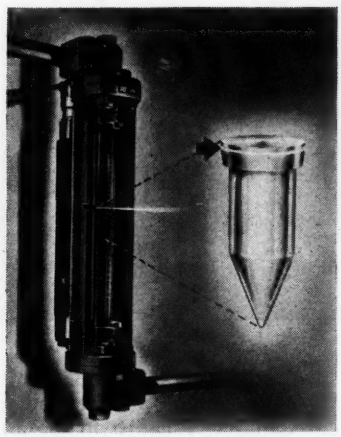
Co.'s 2-in. tube cleaners drives the grinder. One half of a slip-on flexible coupling is fixed on the air motor spindle, the other half being fixed on the grinder spindle. A housing provides easy attachment or detachment of the motor, air hose, shut-off valve and motor lubricator.

The grinding wheel is interchangeable with a wire brush provided for cleaning those gasket seat surfaces which require no refacing. For this operation the grinder is used as a detachable, hand-held cleaning tool and provides a power-driven brush which will serve for a variety of cleaning purposes.

Line-O-Light Rotor for Rotameter

SHARP, clear Rotameter readings of opaque liquids, are obtained with the new Line-o-Light rotor developed by Schutte & Koerting Co., Philadelphia, Pa.

This rotor, having the same basic design as a standard SK rotor, has a disc of light-transmitting material sandwiched in the rotor head which substantially reduces the distance that the light must travel through the opaque liquid from its source



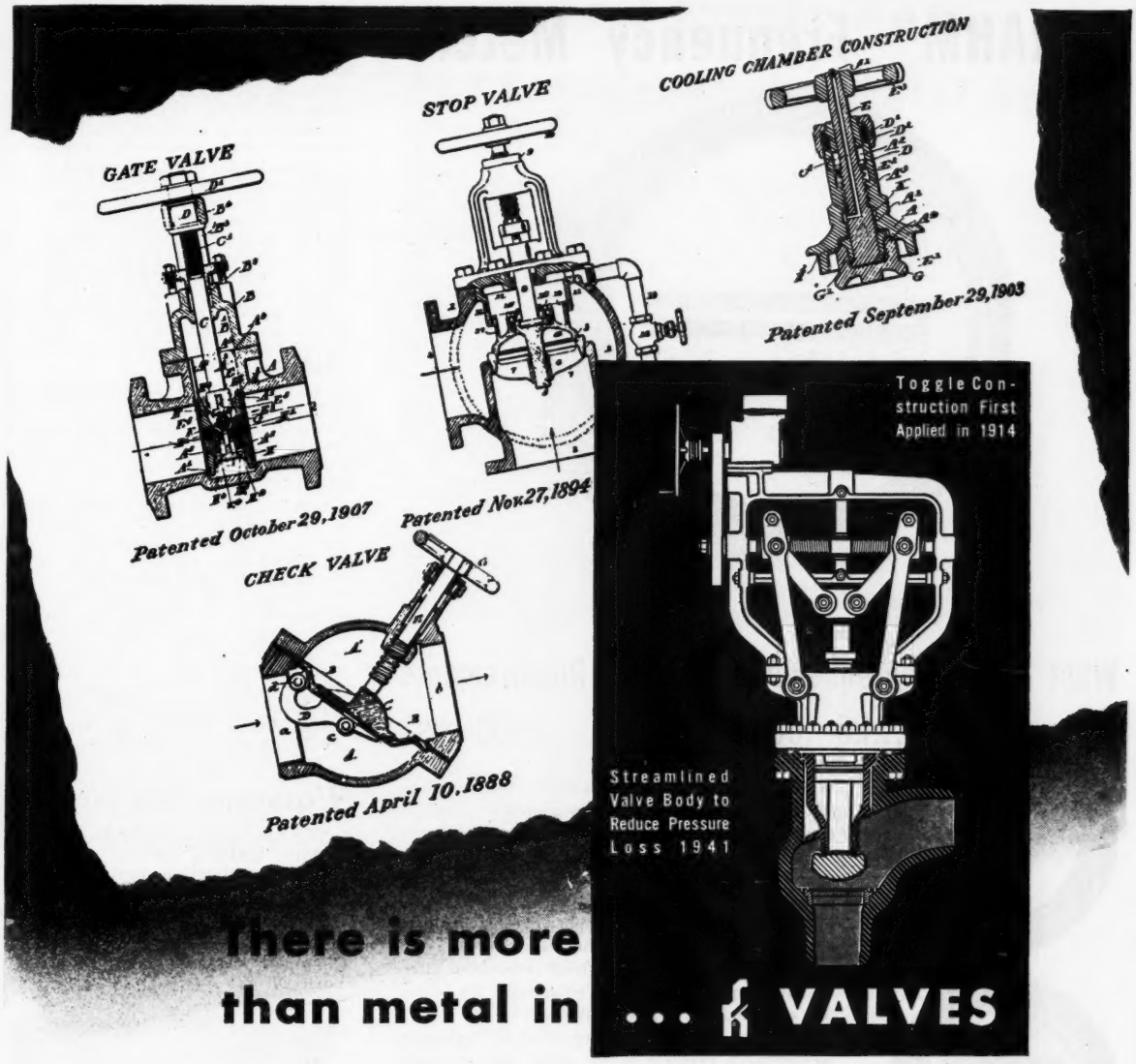
behind the tube. Rate-of-flow is thus delineated sharply in the resultant band of light on the tube reference scale and operators can make easy, accurate readings.

This Line-o-Light rotor can be used for practically any application and in any type tapered glass tube rotameter. Two types of discs can be furnished: Lucite for general applications and Pyrex glass for extremely hot or highly corrosive fluids.

Silicone Rubber

DOW CORNING CORP., Midland, Mich., announces the commercial availability of Silastic, a silicone rubber, produced in various stocks for molding, extruding, coating, and laminating. Largely because of their inorganic origins, these rubbery organo-silicon oxide polymers remain elastic after heating at temperatures up to 500 F and retain flexibility at temperatures as low as — 70 F.

Silastic stocks are available for molding flat sheets, gaskets and


GATE VALVE
Patented October 29, 1907
STOP VALVE
Patented Nov. 27, 1894
COOLING CHAMBER CONSTRUCTION
Patented September 29, 1903
CHECK VALVE
Patented April 10, 1888
Toggle Construction First Applied in 1914
Streamlined Valve Body to Reduce Pressure Loss 1941
There is more than metal in ... SK VALVES

In addition to good materials, there are sixty years of research, design and construction experience in today's SK Valves. Into each one goes ideas which result from long familiarity with the problems involved, from a long established procedure of improving on past performance, and of doing what has never been done before.

Schutte and Koerting valve patents are documented proof of this pioneering leadership. Dating as far back as 1885, these patents cover many ideas which are now standard in the industry. The swing-disc check valve, patented in 1888, the cooling chamber which permits packing of stuffing boxes while the valve is under pressure, patented in 1903, and the cushioning chamber on non-return valves, patented in 1894, are but several of a distinguished list of SK engineering achievements.

Just as Schutte and Koerting was a jump ahead in the days when steam power was beginning to grow, so today their continuing leadership is improving past practices and meeting new demands. Many of these new designs will also become standard when patents expire.

Knowledge, acquired only by long experience, is one of the intangibles which makes SK Valves dependable, trouble-free and up-to-the-minute. Benefit by Schutte and Koerting's proved ingenuity. Specify SK Steam Valves.

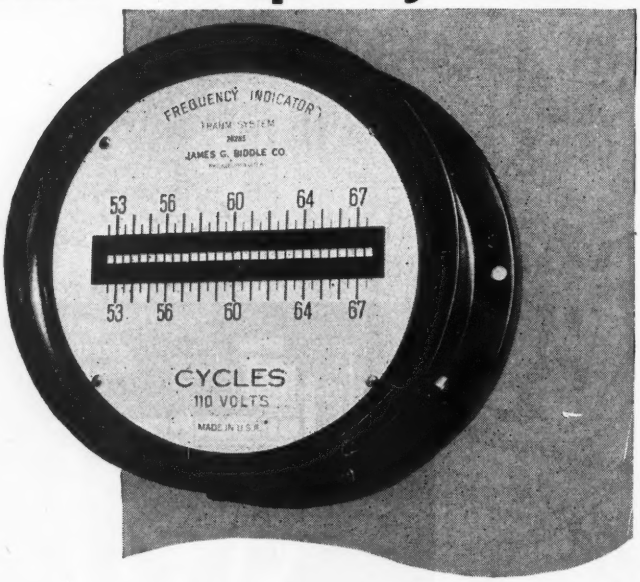
JET APPARATUS • HEAT TRANSFER EQUIPMENT • STRAINERS
CONDENSERS AND VACUUM PUMPS • OIL BURNING EQUIPMENT
ROTAMETERS AND FLOW INDICATORS • RADIAFIN TUBES
VALVES • SPRAY NOZZLES AND ATOMIZERS • GEAR PUMPS

SCHUTTE & KOERTING CO.

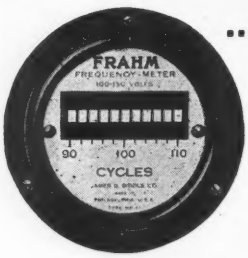
Manufacturing Engineers

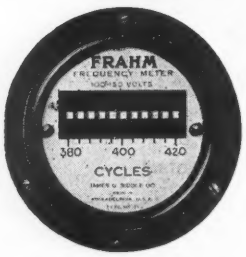
1156 Thompson St., Philadelphia 22, Pa.

"FRAHM" Frequency Meters



What are your Frequency Measuring Requirements ...25...60...100...400.....1400 cps?





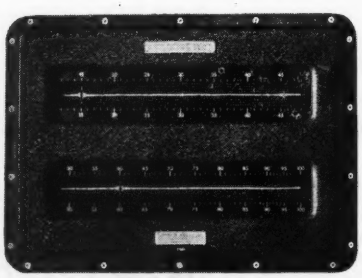
Frahm Frequency Meters in switchboard, miniature and portable types are regularly available for ranges between 15 and 500 cycles per second.

To meet special requirements, our laboratory has designed and built instruments for measuring frequencies as high as 1400 cycles. Such, we find, is possible by means of the same simple and direct resonant reed principle, usually requiring less than 0.1 volt-ampere power input, and without recourse to intermediate frequency conversion equipment. We believe that even higher frequencies are possible.

We invite correspondence regarding any frequency measurement problem in the audio and sub-audio range. For its solution we proffer our instruments, our services and facilities. In our 30 years of association with the resonant reed principle as applied to the measurement of frequency, we have been instrumental in the solution of a surprising variety of problems.

Write for Bulletin 1770-PE now in preparation.

This instrument was developed for direct indication of frequencies in the lower audio range and for simultaneous direct indication of harmonic components. Called a Harmonic Analyzer, it has unusual electrical characteristics and a wide range, with a total of 288 reeds.



JAMES G. BIDDLE CO. 1211-13 ARCH STREET PHILADELPHIA 7, PA.

other shapes. Silastic coated lead wire and other continuous extruded shapes are made from Silastic stocks designed for extruding.

Also available are Silastic stocks compounded for coating glass or asbestos cloth to produce flexible, waterproof, heat stable, oil resistant gaskets, diaphragms, tape and electrical insulation which is nontracking, arc and oxidation resistant. Laminates may be made by curing under pressure multiple layers of Silastic coated inorganic fabrics. Silastic is also used to insulate wire wound resistors with waterproof, heat resistant, elastic coatings able to withstand the severe and repeated thermal shocks specified for Grade I Class I resistors.

Silastic coatings adhere to glass, vitreous enamel, iron, steel and aluminum. They constitute protective coatings which are resistant to oil and salt brines at elevated temperatures.

Silastic stock now available has exceptional temperature stability, tensile strength of from 200 to 330 psi, elongation ranging from 70 to 115 per cent, high resistance to water, brine and oil, and electrical properties of the following magnitude: dielectric constant at 1,000,000 cycles of 5.0 to 7.5; power factor at 1,000,000 cycles of 0.13 to 0.18 per cent; and dielectric strength of 500 per mil. The properties of Silastic stocks, notably their tensile strengths, are being steadily improved.

Waterproofing Liquid

WATERPROOFING LIQUID for electric motors, ignition systems, batteries, internal-combustion motors, wiring and numerous other devices subject to corrosion or affected by water or moisture, has just been released for civilian use by U. S. Industrial Chemicals, Inc., 60 E. 42nd St., New York, N. Y.

Known as PiB, the liquid insulation product has been widely used by the armed forces for waterproofing ignition and preventing battery corrosion of jeeps and amphibious vehicles. The illustration shows a 110-v, ½ hp single-phase electric motor and exposed electric bulb which, after treatment, have operated continuously while completely submerged in the aquarium tank for over 2 yr.

Your Condensers Last Longer When APEXIOR NUMBER 3 Keeps the Metal Dry

In condensers and cooling equipment accelerated corrosion is prevented, when metal is coated with APEXIOR NUMBER 3.

Whether the water is salt or fresh, as long as its temperature remains under 125°F., APEXIOR NUMBER 3 protects the metal it covers . . . with a film a few thousandths of an inch thick. Many years of successful application to the water-side of cold water tanks, stern plates of marine vessels, potable water tanks, condensers and water-cooling equipment prove its ability to give metal surfaces longer life.

What is APEXIOR NUMBER 3?

APEXIOR NUMBER 3 is a shiny-black technical protective coating made of 100% asphalts dissolved in a suitable completely-volatile solvent. When dry it is non-toxic, stable and wear-resistant.

To prepare for APEXIOR NUMBER 3, clean surfaces thoroughly to bare metal — sandblast if possible — then apply two coats of APEXIOR NUMBER 3 like a paint, using a hand brush. An original abrasive blast cleaning (never again necessary) prepares for a permanent maintenance base upon which APEXIOR protection can be established. For internal surfaces of tubes, special brush equipment is available for use with standard air turbines. APEXIOR NUMBER 3 is shipped ready-for-use — no thinner permitted.

Here's economical insurance against the destructive effects of water-contact for any metallic cold-water handling equipment.

Get additional details today. Use the coupon below or your own letterhead. The Dampney Co. of America, Waterman Bldg., Hyde Park, Boston 36, Mass.

APEXIOR

Keeps new metal new . . . Gives old metal new life

DAMPNEY

THE DAMPNEY COMPANY OF AMERICA
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Please send free Bulletin 1290.

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THE HEART OF A DART

is the True Ball Joint of its Two Bronze Seats

Bronze-to-bronze seats, ground to form a true ball joint, distinglish the Dart Union from all others. Tight coupling is attained without a jam joint; thus Darts may be taken down readily, and used over and over again. Pipe ends and nut are made from high-test, air-refined malleable castings; have high tensile strength and yield point; are practically indestructible. In length of trouble-free service, Darts are easily the most economical unions. Your supplier will be glad to demonstrate Darts' superiority.

DART UNIONS

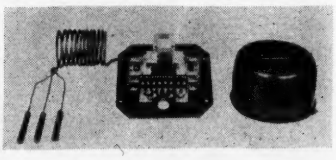
DART UNIONS LIVE LONGER

E. M. DART MFG. CO., Providence 5, Rhode Island

Winding-Temperature Relay Equipment

A WINDING-TEMPERATURE RELAY, which permits utilization of the maximum permissible emergency-overload capacity of power transformers under all ambient temperature conditions, has been announced by General Electric Co., Schenectady 5, N. Y.

This equipment, which can be supplied on all new G-E power transformers, operates from a combination of top oil temperature, ambient temperature, and load current, and thus enables winding hot-spot temperatures to be limited to values recommended by industry standards. The relay has three separate contacts, which close in sequence as the winding temperature increases. On a transformer with cooling fans for supplementary rating, the relay can perform the following operations: 1. Start cooling fans as soon as the self-cooled, load-carrying capacity of the transformer is exceeded; 2. Give a warning signal as soon as overload has been on for the permissible length of time; 3. Sound an alarm or trip the circuit breaker, taking the transformer off the circuit when the overload exceeds specified limits.



The relay, which is mounted on the outside of the transformer tank at a convenient working height, can be easily checked in the field without interrupting the load on the transformer. It is self-compensating for ambient temperature, assuring correct maximum loading under all ambient conditions.

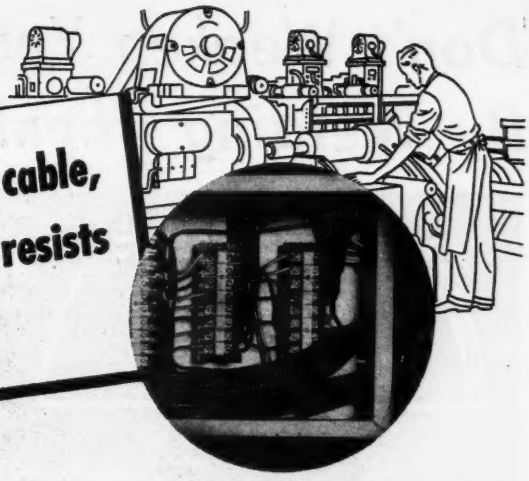
Obituaries

J. F. Gilchrist

JOHN F. GILCHRIST, 77, of Chicago, retired vice president of the Commonwealth Edison Co. and one of the pioneers of the nation's electric utility business, died August 4 after a long illness.

He retired December 31, 1942, as vice president of the Company after 55 years of service but remained as chairman of the Chicago and Illinois Midland Railway, a subsidiary.

Mr. Gilchrist started his career as an office boy with the Chicago Edison Co. a few months after it was organized in 1887. It was the predecessor of Commonwealth Edison. Shortly afterward he became the first employe in the meter department. He was appointed assistant to the president in 1906, and was elected vice president in charge of purchasing, stores, transportation, and statistical department in 1914.



PROBLEM: to find insulated cable, for wiring machine tools, which resists all kinds of cutting fluids

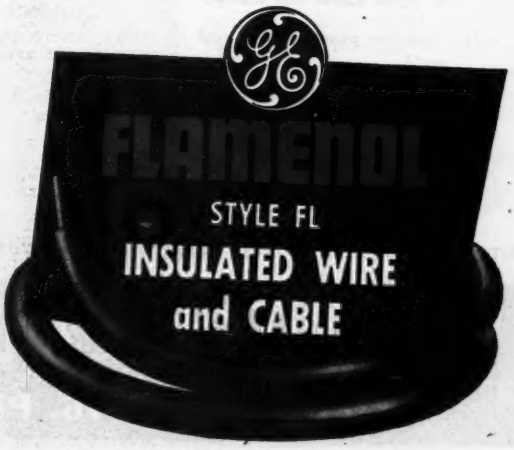
First solved with FLAMENOL *cable*

● Not long after the introduction of Flamenol*, in 1935, a prominent manufacturer of automobiles was searching for insulated cable which would withstand machine-tool cutting oils and coolants. When a G-E sales engineer showed the manufacturer a sample of Flamenol—and described its excellent resistance to oils, water, and heat—the company's chief electrician immediately ordered 6000 feet. The company found this cable so satisfactory that it now specifies Flamenol to be installed on all the machine tools it buys. If you have a problem of finding insulated cable or wire that will withstand severe conditions, such as contact with cutting fluid, Flamenol may very likely be the answer. It has proved its many desirable properties in hundreds of power and lighting applications.

RESISTS FLAME—Flamenol does not support combustion. Thus, it prevents serious outages due to fires that involve wiring. Requiring no protective braid, it reduces the volume of wiring and eliminates terminating problems due to fraying. Flamenol's insulation strips easily and leaves the conductor surface untarnished. It is highly resistant to oils, water, mild acids and alkalis, and weather. It is tough, stable, and flexible at low temperatures, and has high dielectric strength.

A G-E "FIRST"—Only G.E. makes Flamenol wire and cable. Flamenol is the pioneer of wire and cable insulated with plasticized polyvinyl chloride. It was produced by G.E. in 1935—not as a substitute for rubber-insulated wire, but as a new type possessing desirable properties not available with rubber. To find out how Flamenol can help solve your problems—save you time, trouble, and expense—ask our local office, or write General Electric Company, Schenectady 5, N. Y.

*Trade-mark reg. U.S. Pat. Off.

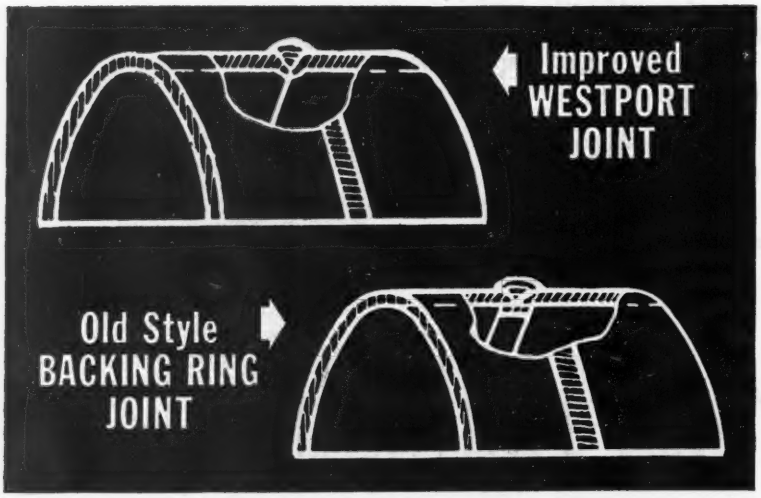


GENERAL ELECTRIC

502-52-1200

Buy all the BONDS you can—and keep all you buy

Don't Weaken Your Pipes By Welding Them Wrong



THE WESTPORT JOINT

Produces *SOUND* Welds

Here's why **The Westport Patented Joint welding permits fusion buttwelded joints to be made from one side only, with complete penetration to the root of the weld. This new method . . . especially suitable in the welding of heavy wall piping for high pressure temperatures . . . is proving satisfactory in lines operating at 1250 pounds per square inch and 925 degrees F. total temperature steam service, on installations made as early as 1939.**

The Westport Welded Joint provides:

(1) Greater Flexibility in Alignment of pipes, valves and fittings.

(2) Complete penetration to root of weld.

(3) No constriction in pipe area due to Backing Rings.

(4) No sacrifice in strength of the pipe due to removal of wall or Backing Ring.

(5) Smooth pipe contour at base of weld with no "icicles" or protrusions.

(6) Meets A.S.M.E. Code Requirements.

1899 1945

WRITE FOR BULLETIN AND DETAILED LITERATURE WITHOUT DELAY

W. K. MITCHELL & CO., Inc.

PHILADELPHIA 46, PENNA.

Mr. Gilchrist took a leading role in national utility activities. He was a past president of the Association of Edison Illuminating Companies, the National Electric Light association and the Electric Association of Chicago. He also was a leading supporter of the Illinois Children's Home and Aid Society, the Salvation Army, the American Red Cross, Chicago Civic Opera Company, and the Chicago Community Fund.

John B. Berryman

JOHN B. BERRYMAN, Chairman of its Board of Directors of Crane Co., since 1935, died in Chicago on Friday, August 10, at the age of 83, after 53 years of service with the company.

Mr. Berryman was born and received his early education in Canada, coming to Minneapolis in 1885 where he started as a bookkeeper in the plumbing supply company that later became Crane Co.'s Minneapolis branch. After a few years as manager of that branch, he was made manager of the company's newly created engineering sales department in Chicago.

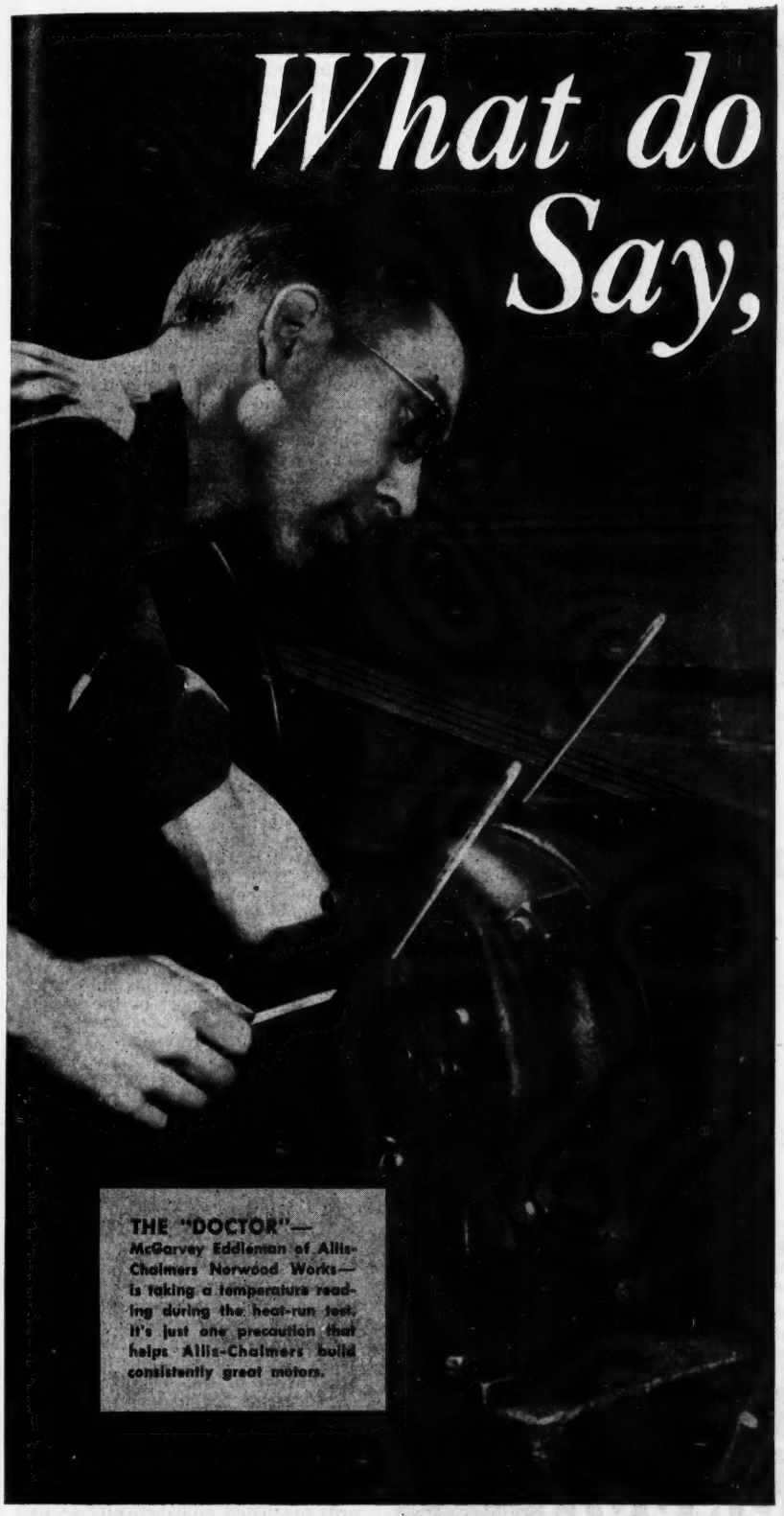
In 1911, he became secretary of the company and the following year, upon the death of R. T. Crane, the founder, he was elected a director and 3rd vice-president. He served as a director from that time until his death. In 1914, he was advanced to 1st vice-president, which position he held until his election to the presidency of the company in 1932. He served in this capacity during the trying years of the depression and in 1935 relinquished active management to younger men.

New ENGINEERING BOOKS

The Steam Boiler Yearbook and Manual. Edited by Sydney D. Scorer; copyrighted 1945; third edition; size 6 by 9 in.; 570 pages; hard binding; published by Paul Elek (Publishers) Ltd., Africa House, Kingsway, London, W. C. 2, England. Price 30 shillings.

Although published in England, this Steam Boiler Yearbook is not confined to steam generating practice in Great Britain but reviews present practice in other countries as well, devoting much of its space to American equipment and methods. It is designed essentially to inform the reader regarding current practice. The book is divided into two parts. Part I consists of 25 chapters. In these, recent developments are reviewed, gas firing is treated, accessories are described, boiler deposits are considered, and a book review section is incorporated. Part II is made up of five chapters dealing with fuel utilization, combustion appliance developments, feedwater and steam problems, fire side problems, and modern practice and developments. This book deals with the practical problems of steam generation in a non-technical manner but is very

What do You Say, Doc?



THE "DOCTOR"— McGarvey Eddleman of Allis-Chalmers Norwood Works—is taking a temperature reading during the heat-run test. It's just one precaution that helps Allis-Chalmers build consistently great motors.

NO—THAT'S NOT a sick motor. Actually it's a very *healthy* one. But that's something we must know — through generous sample testing — before Allis-Chalmers motors can tackle jobs for you.

Part of the "physical exam" that motor at the left must pass is the heat run test. Bristling with thermometers, the motor runs at full load — and speed and temperature are recorded for every hour.

Five or six hours can tell you a lot about a motor's characteristics —but it takes more like five or six *years* to tell you its *character.*

And it's the test of time in which Allis-Chalmers motors have established that they are *great* motors. That's why you hear so many engineers say: "You can depend on Allis-Chalmers Motors!"

• • •

If you could meet and talk with the men who build Allis-Chalmers motors, you might be surprised to learn how keenly they are aware of the big *personal* stake they have in every motor they build for you.

They know that factory tests to fully pre-determine how well a motor is built *just don't exist;* that there's still no substitute for responsible craftsmanship.

And they know that when they build great motors for you they're making *friends*—and that no company and its workers can have too many of them. ALLIS-CHALMERS, MILWAUKEE 1, WIS. A 1726

YOU CAN DEPEND ON ALLIS-CHALMERS MOTORS

Steam Carried Long Distances with Minimum Heat Loss

For an efficient steam line installation, you will put the pipe underground where it is out of the way — give it the best protection against moisture that you can—insulate it to keep the heat in the line to the point of delivery.

That's just the combination you get when you run your steam lines in ADSCO-Bannon Tile Conduit. Made of vitrified clay tile, installed with ADSCO Filler Insulation (a "Fiberglas" Product) it can't be topped for permanency or thermal efficiency.

Furnished for several combinations of pipe in the same conduit. Split tile construction makes pipes readily accessible for threading or welding. Highly skilled labor not required.

Base drain carries away ground seepage water — keeps insulation dry — prevents undue heat loss. Write for quotation giving length of line and size of one or more pipes to be insulated and Bulletin No. 35-67E.

AMERICAN DISTRICT STEAM COMPANY
N. TONAWANDA, N. Y.
MAKERS OF "UP-TO-DATE" STEAM LINE EQUIPMENT FOR OVER 65 YEARS

Write for Quotation On

ADSCO-BANNON
TILE CONDUIT
WITH ADSCO FILLER INSULATION
(A "Fiberglas" Product)

clear in its explanation of the principles of operation of boiler house equipment, and is commercial to the extent that it deals with manufactured equipment used in modern practice.

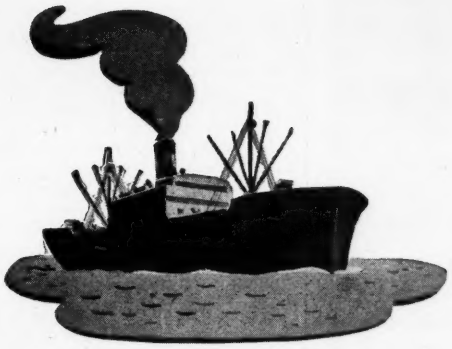
ASTM Specification for Steel Piping Materials. Prepared by Committee A-1 on Steel. Copyright 1945; size 6 by 9 in., 344 pages; paper bound; published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia 2, Pa. Price $2.00.

Through the work of ASTM Committee A-1 on Steel, many specifications have been developed for the use of those concerned with the use of steel piping materials and their production, and this book is a compilation of all such information brought together in a handy up-to-date file. The specifications are grouped under the following headings: Piping; welded and seamless, black and hot-dipped, electric-fusion-welded and electric-resistance-welded, spiral-welded, high temperature and high pressure service pipe, welded wrought-iron, welded alloy open-hearth. Boiler, Superheater, and Miscellaneous Tubes; lap-welded, and seamless, electric-resistance-welded, medium-carbon, high pressure tubes, copper brazed steel tubing, stainless steel tubing for general service, seamless and welded austenitic for the dairy and food industry. Still Tubes for Refinery Service. Heat-Exchanger and Condenser Tubes; seamless cold-drawn low-carbon, and intermediate alloy-steel, and electric-resistance-welded steel. Castings. Forgings and Welding Fittings. Bolting; alloy steel for high temperature service and for service from 750 to 1100 F, carbon and alloy-steel nuts for high pressure and high temperature service, and heat-treated carbon-steel bolting material. Grain Size. Emergency Alternate Provisions. The methods and specifications given in this publication have the full support of the society and are recognized as standards by the engineering profession.

MANUFACTURERS' *News*

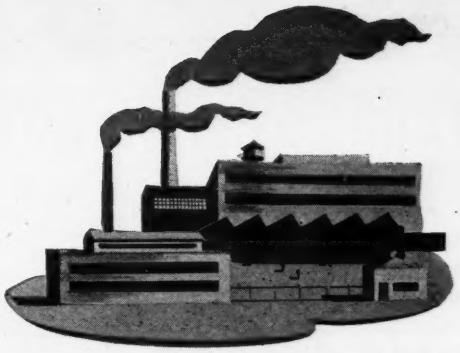
American Standards Now Available

A NEW LIST of all American Standards and War Standards approved to date has just been published by the American Standards Association. There are approximately 800 standards listed in the booklet, covering specifications for materials, methods of tests, dimensions, definitions of technical terms, and procedures, in the electrical, mechanical, building, transportation, textile, and other fields. For ready reference, the Standards are listed alphabetically as well as by engineering fields. There is also a separate list of the War Standards. Since the war, the ASA has been working very closely with government agencies and with the Armed Services to provide specifications for



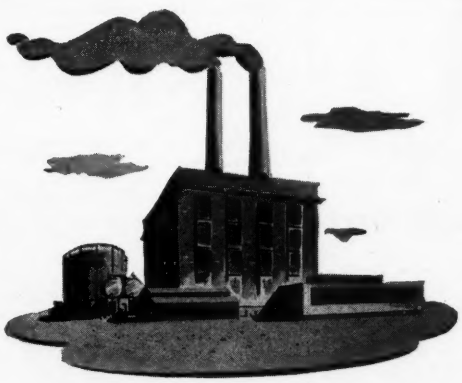
COOLER — CLEANER — LONGER LIFE

Early tube failure was traced to plug-type dezincification, with a change of metal indicated. But Scovill *Service in Metals* blamed unusually high temperatures and insufficient tube cleaning. Better operation lengthened life of replacement tubes many years.



LOCALIZED INFECTION CURED

Persistent failure of two rows of tubes in the first pass of a condenser was puzzling, because tubes in adjacent areas were normal. Scovill *Service in Men* helped the chief engineer work out an inexpensive construction change, ending the premature failure.



USEFUL TO UTILITIES

Scovill's Condenser Tube Booklet will be found in many a utility power plant — on industrial and marine engineers' desks, too — because it gives valuable information on metals, installation, analyzing trouble sources. It is part of Scovill's *Service in Manuals.*

Many power plant operators look first to Scovill for news on new developments... advice on installation practice... help in solving problems — because Scovill is

One Company Which Gives You

ONE PRODUCT

... Condenser Tubes

THREE SERVICES

For a free copy of the new Scovill Condenser Tube Booklet, write SCOVILL MANUFACTURING CO., 17 Mill St., Waterbury 91, Conn.

Nothing to get out of order in this

BRIGGS LUBE OIL CLARIFIER

Briggs Fullers Earth Cartridges clean straight mineral oil 3 times—3 ways, remove visible and invisible contaminants. Briggs Discel Cartridges remove dirt from additive-type oils without affecting the action of the additive. Both are interchangeable in all Briggs Clarifiers.

DR Series Lube Oil Clarifiers are available in capacities ranging from 1GPM to 20GPM.

Dirty oil goes in—Clean oil comes out

Briggs DR Series Lube Oil Clarifiers are designed for simplicity of operation—THAT'S WHY MAINTENANCE IS SO LOW. Not one moving part to give trouble . . . Just change the refills when necessary—that's all!

A simple, effective refill sealing assembly, a permanently set relief valve and Briggs Patented Fullers Earth or Discel Cartridges do the complete job.

Whatever type of oil you use, whatever size or type internal combustion engine you operate, this SIMPLICITY will save you MORE money while maintaining your lube oil effectively.

Get the facts and literature about Briggs Oil Clarification from the Briggs distributor nearest you. Consult the "Filters" section of your classified telephone directory, or write direct to manufacturer.

Briggs

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certain of the materials necessary to our war effort. Because these standards are developed through an accelerated procedure, they are designated as American War Standards. To date, there are 117 completed War Standards and many more under development. These war standards have been produced in the field of safety work, machine tools, quality control, photography and radio.

This list represents the cumulative efforts of the past 26 years on the part of many organizations working through the American Standards Association.

In each case the standards represent general agreement on the part of maker, seller, and user groups as to the best current industrial practice. More than 600 organizations are taking part in this work.

This complete list will be sent free of charge to anyone interested in this work upon request addressed to the American Standards Association, 70 E. 45th St., New York 17, N. Y.

Library to Commemorate J. R. Allen

ESTABLISHMENT OF THE John R. Allen Memorial Library by the American Society of Heating and Ventilating Engineers, has just been announced. It is planned that this Library of books, pamphlets, and other printed matter dealing with the arts and sciences of heating, ventilating and air conditioning will be located in the Society's Research Laboratory, 10700 Euclid Ave., Cleveland, Ohio. Authors of text books, and reference books are invited to contribute gift copies and members and friends of the Society are urged to send text books and any other printed material of historical value to this newly created Library.

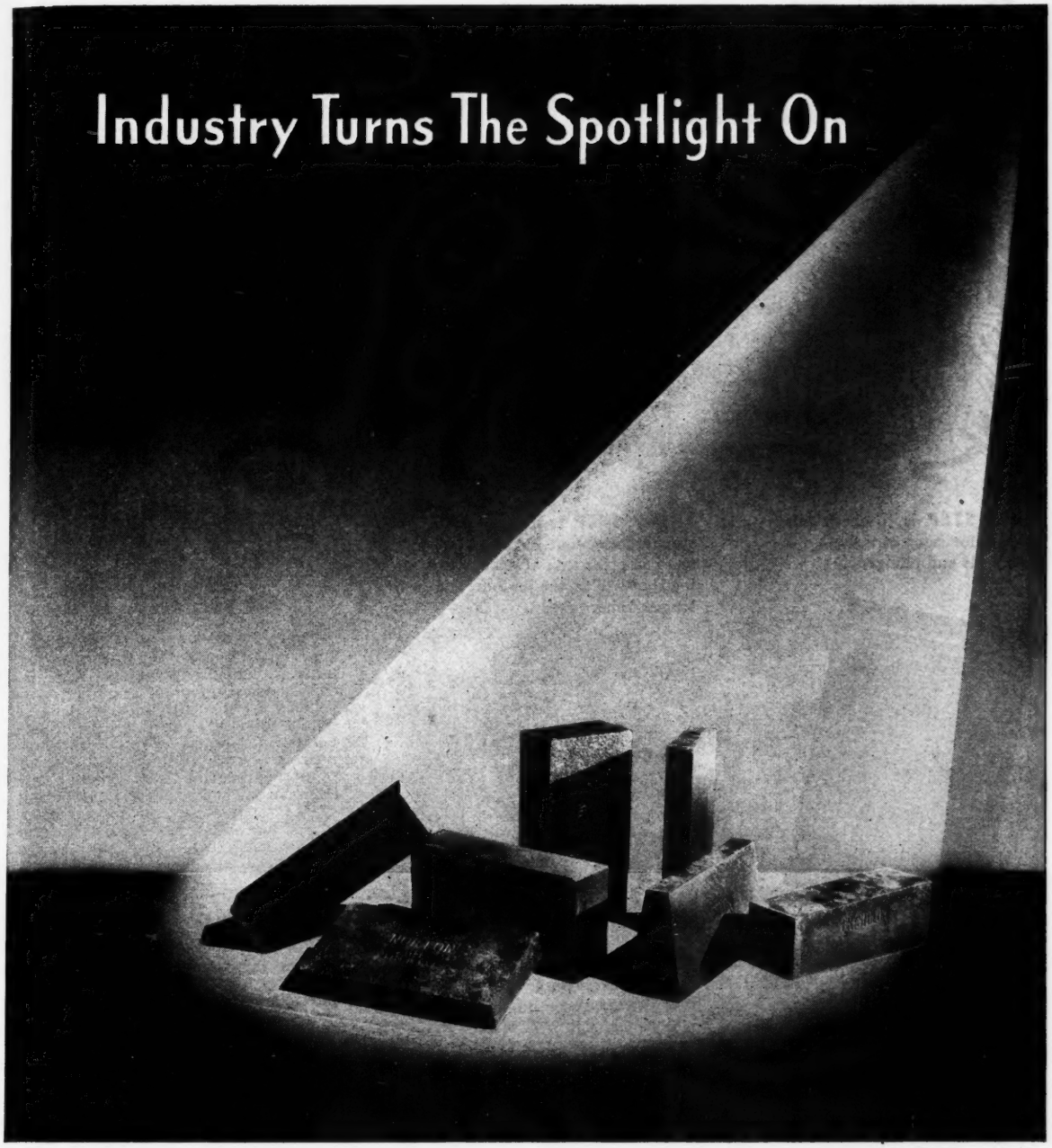
Because of his pioneer work in the establishment of the ASHVE Research Laboratory and as its first director, it was considered fitting by the Committee on Research that the Library should commemorate the memory of John R. Allen.

He was a man who combined the characteristics of the educator, the scientist and the engineer, and was a prolific writer. He served as president of the Society in 1912 and became active head of the Society's Research Laboratory at the Bureau of Mines, Pittsburgh, Pa., on August 1, 1919.

He was born in Milwaukee, July 23, 1869, graduated from the University of Michigan in 1892, received his Masters degree in M.E. in 1896 and joined the faculty of the University of Michigan and served there until 1911. He then went to Turkey as head of the engineering department of Robert College and in 1915 returned to the University of Michigan and was head of the Department of Mechanical Engineering. In 1917 he became Dean of the College of Engineering and Architecture of the University of Minnesota.

After serving as Director of ASHVE Research Laboratory for a little more than a year, he died at the age of 51, October 26, 1920.

Now, as the 25th anniversary of his death approaches, his many friends in the Society believe that



CRYSTOLON BRICK

Wartime peak operation emphasizes CRYSTOLON Brick's outstanding quality—long, trouble-free service . . . a serviceability derived from these characteristics: (1) great refractoriness, (2) chemical stability, (3) resistance to abrasion, (4) resistance to the corrosive action of ash and the penetration of slag.

NORTON COMPANY — Worcester 6, Mass.

How To Give Stuffing Boxes
THE "BELMONT CURE"

FIRST STEP is to check pumps and engines for signs of leaking valves, pistons, rods and plungers.

THIRD STEP is to have a supply of standard Belmont Packings on hand so as to stop the leak at once with a packing that will do the job best and for the longest time.

SECOND STEP is to refer to Belmont PACKING RECOMMENDATION CHARTS which quickly identify the right packing type for each set of operating conditions.

BELMONT DISTRIBUTORS are located in every large industrial center, ready to serve you promptly from local stocks. Get the PACKING RECOMMENDATION CHARTS from the one nearest you — or send the coupon to us.

THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

on the blue-and-orange box

THE BELMONT PACKING AND RUBBER COMPANY
Butler & Sepviva Streets, Philadelphia 37, Pa.

Gentlemen: Please send PACKING RECOMMENDATION CHARTS for the services checked:

☐ Steam . . . ☐ Hot Water . . . ☐ Cold Water . . . ☐ Brine . . . ☐ Ammonia . . .
☐ Acids & Caustics . . . ☐ Air . . . ☐ Gas . . . ☐ Oil . . . ☐ Gasoline . . .
☐ Asphaltic & Tar Products . . .

Name .....
Company .....
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his name should continue to be closely associated with the future development of the Society's research work.

Standard Oil to Expand Research

PLANS FOR THE establishment of an engineering research department and for expansion and reorganization of present engineering activities have been announced by Standard Oil Co. (Indiana). George W. Watts has been named director of engineering of the manufacturing department and D. A. Monro, chief designing engineer of the department. Under the new plans Mr. Watts will be in charge of all engineering work in the manufacturing department but will devote his time principally to the activities of the engineering research department. All other engineering activities will be under the direct charge of Mr. Monro.

P. L. Krauel has been appointed chief engineer of the engineering division, Whiting Refinery, where the Company's largest engineering unit is located. Mr. Krauel will serve as the administrative head of the division which has been enlarged to include six departments, each to be headed by an assistant chief engineer.

The oil design department will be supervised by W. G. Guild, acting assistant chief engineer. A. T. Milbrook, assistant chief engineer, will supervise the utility design department. W. K. Brown has been appointed acting assistant chief engineer in charge of the newly-created plant engineering department. This department will handle engineering matters pertaining to construction, inspection and field engineering, and will furnish consulting services to the operating and design departments. C. E. Dyckman is made assistant chief engineer, estimating department, and will continue to direct and supervise the work of the estimating engineers. W. R. Burrows will be in charge of the newly-created engineering development department, with the title of assistant chief engineer. D. F. Purdy, assistant chief engineer, will continue to supervise the drafting department.

Bendix Establishes New International Division

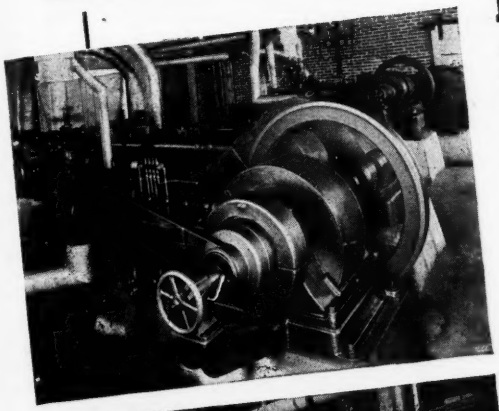
FORMATION OF A NEW division, Bendix International, to handle the foreign trade program of Bendix Aviation Corp., has been announced by Ernest R. Breech, president.

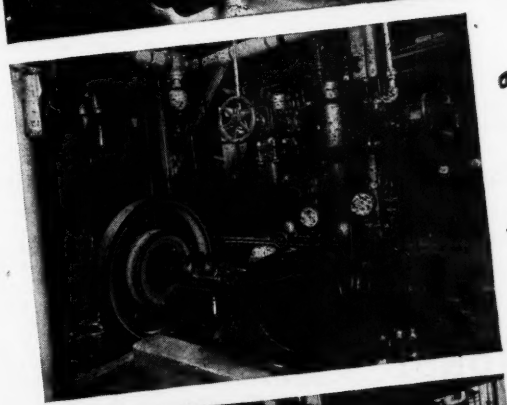
Bendix International will be under the direction of Charles T. Zaoral, general manager, who joined the corporation in January as coordinator of foreign affairs, after many years of experience in the foreign field for General Motors Corp. and Dodge Brothers, Inc.

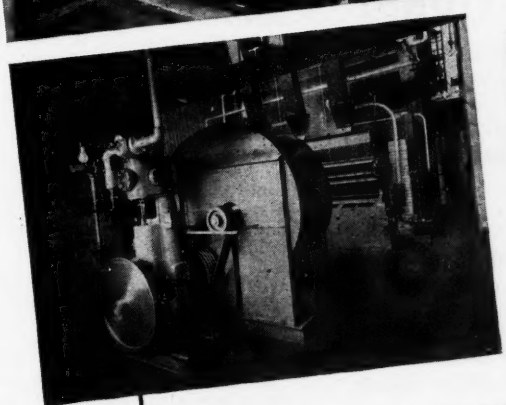
The new division will handle throughout the world with the exception of the United States and Canada, the products of the seventeen divisions of the corporation. It has established headquarters at the corporation's New York office, 30 Rockefeller Plaza, and will maintain a staff of engineering, sales and serv-

Experts Advise:-

"Extract By-Product Power From Steam"







FUEL and power experts seeking ways for reducing cost of steam generated for processing purposes are advising that wherever possible inherent power in the steam be extracted and used. One of the simplest and surest ways of utilizing By-Product Power is to use it to drive a Troy-Engberg Steam Engine. After the power has been used, steam is exhausted from the engine and passed on to the task for which it was generated.

The power thus converted can be used in two ways:

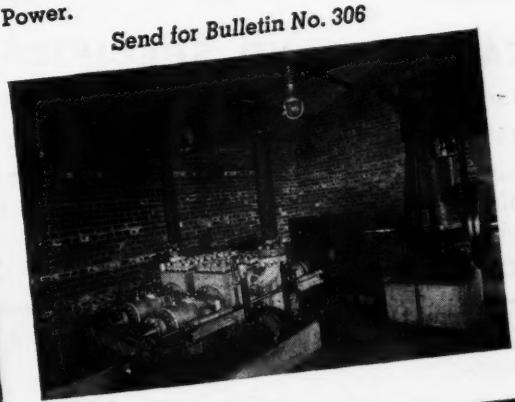
1. As a direct drive for stokers, compressors, fans, and other equipment

or 2. To drive an efficient Troy-Engberg generator, either AC or DC, to supply current for whatever purpose it is desired.

On such applications Troy-Engberg Steam Engines pay for themselves in a surprisingly short time — often in less than a year.

In your planning for post-war economies, don't overlook the possibilities of By-Product Power.

Send for *Bulletin No. 306*



TROY ENGINE & MACHINE CO.

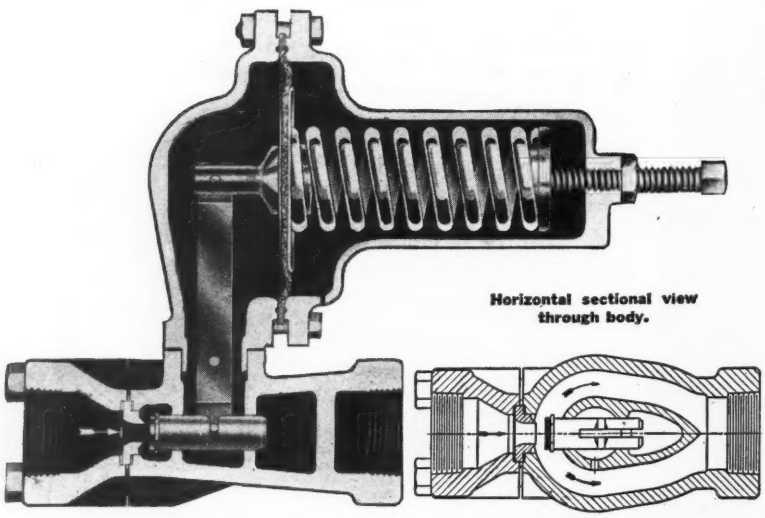
ESTABLISHED 1870
879 RAILROAD AVENUE, TROY, PENNSYLVANIA

9-THM-4

FISHER "BIG JOE"

FOR AIR PRESSURE REDUCTION THROUGHOUT THE POWER PLANT

Easy to Install . . . Simple to Adjust . . . Requires Only Limited Installation Space Extra Large Capacity . . . Accurate and Dependable . . . Rugged Construction . . . Trouble Free Long Life . . .



Horizontal sectional view through body.

FEATURES AND SPECIFICATIONS:

1. Exclusive design provides unusually large capacity.
2. Maintains reduced pressure setting within very close limits.
3. Extremely compact (15 to 16" overall length, maximum height 10½") — easy to install — controlled pressure setting easily changed.
4. Can be installed in any desired position.
5. Two diaphragm assemblies for reduced pressure ranges of 5 to 30 PSI and 27 to 150 PSI — interchangeable on both body sizes.
6. Body and spring housing heavy high-tensile iron — inlet adaptor malleable iron for pressures up to 1000 PSI — orifice brass or stainless steel.
7. Pipe sizes 1" and 2" — various orifice sizes as required.

Write today for Bulletin 43F.

FISHER GOVERNOR COMPANY
1028 Fisher Bldg. • MARSHALLTOWN, IOWA

ice personnel which will be expanded here and abroad as world conditions permit.

Iron Fireman Acquires Teeple Co.

THE IRON FIREMAN MANUFACTURING Co. has taken over the plant and business of the L. R. Teeple Co., makers of automatic heating control instruments. Operation under Iron Fireman management became effective August 1.

Production at the Teeple plant has been concentrated almost entirely on control instruments made for Iron Fireman since its beginning in 1923, except during the recent war years when production has been primarily war equipment. The plant will now be known as the heating control division of the Iron Fireman Manufacturing Co.

Square D in New Plant

SQUARE D Co. Canada Ltd., affiliate of Square D Co., Detroit and Milwaukee, shortly will begin operations in its newly constructed plant in Toronto, Henry Morgan, of Detroit, president of the Canadian company, announced.

The new plant and office buildings are located on a tract of land which provides still more room for expansion in the postwar period. Total floor space of the new facilities is approximately 60 per cent greater than that in the plant and office being vacated, originally the Ford Motor Co. of Canada Ltd.'s Toronto operation.

Westinghouse Acquires B. F. Sturtevant Co.

ACQUISITION OF THE B. F. Sturtevant Co., of Boston, Mass., the pioneer in the design and manufacture of air handling and processing equipment, has been announced by the Westinghouse Electric Corp.

The Sturtevant Co. becomes a wholly-owned Westinghouse subsidiary operating as the B. F. Sturtevant Co., a Division of Westinghouse Electric. Management of the Sturtevant Co. will be assumed by Westinghouse about September 1.

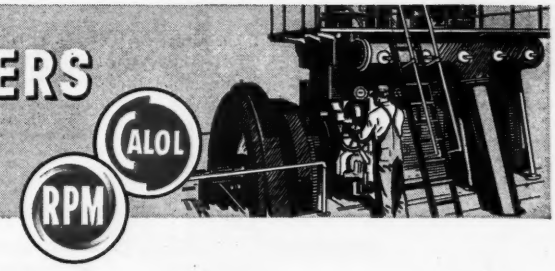
The Sturtevant Co.'s products cover a wide range in the fan and blower field, heating, cooling and air conditioning apparatus, including application and design of complete air handling and processing systems for industry.

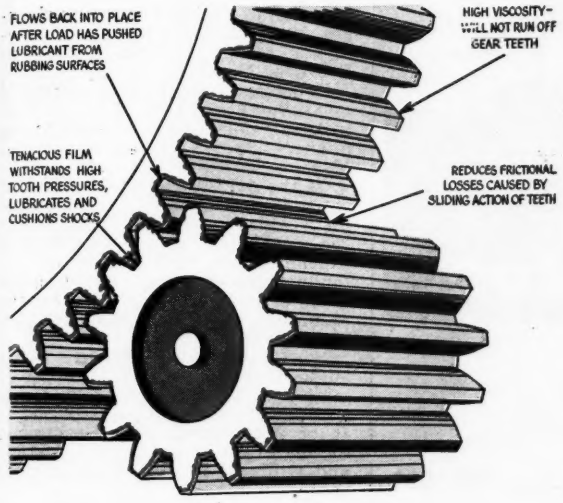
The headquarters of the expanded Westinghouse air conditioning activities will be located at Boston, but heavy-duty and industrial refrigeration manufacture will continue at Jersey City, N. J., along with production of the Precipitron, the Westinghouse-developed electronic air cleaner which removes up to 95 per cent of air-borne dirt particles.

Westinghouse Plans $11,500,000 Expansion

AN $11,500,000 expansion program to permit overall production 50 per cent greater than prewar of existing

STANDARD ENGINEERS NOTEBOOK




FLOWS BACK INTO PLACE AFTER LOAD HAS PUSHED LUBRICANT FROM RUBBING SURFACES
HIGH VISCOSITY—WILL NOT RUN OFF GEAR TEETH
TENACIOUS FILM WITHSTANDS HIGH TOOTH PRESSURES, LUBRICATES AND CUSHIONS SHOCKS
REDUCES FRICTIONAL LOSSES CAUSED BY SLIDING ACTION OF TEETH

Adhesive greases cut gear wear

Constant protection against wear, frictional loss and metal fatigue on gears may be obtained by using Calol Pinion Greases. Recommended for open and encased spur, herringbone and worm-type gears, tenacious Calol Pinion Greases will not drip off. When pushed off in use, they flow sufficiently to recover gear teeth.

Calol Pinion Grease—0. For open or encased gears, but particularly adaptable for exposed high-speed gears in cold weather. May be used on wire rope.

Calol Pinion Grease—1. For medium-speed exposed gears. Much heavier and more adhesive than No. 0.

Calol Pinion Grease—2. For open spur gears in normal conditions. Requires heating for application.

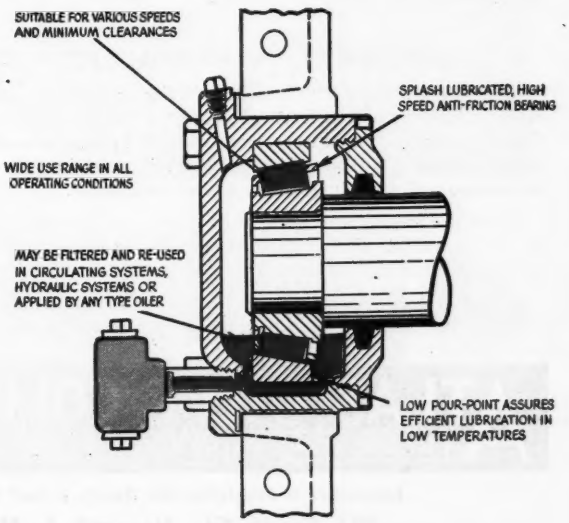
Calol Pinion Grease—5. For open spur gears in severe pressure and temperature conditions. Very heavy and adhesive.

Stable oil prevents clogging high-speed bearings

Many operators, desiring a single oil that will efficiently lubricate a wide range of small-clearance bearings of various types, have found Calol Engine Oil—8 ideal.

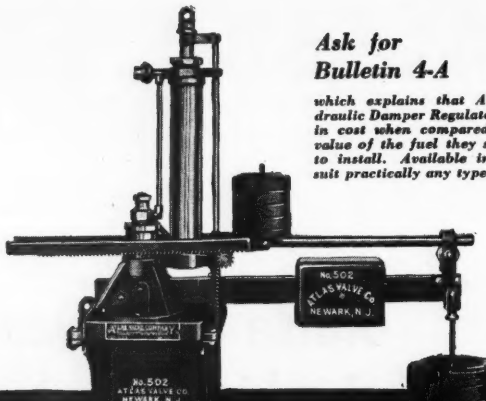
Especially recommended for the lubrication of bearings on generators, motors and other high grade machinery, Calol Engine Oil—8 will not gum and stop up passages. It may be applied by ring-, bottle-, drop- and wick-oilers and by hand oiling. It is also suitable for use in circulating systems, hydraulic systems and may be filtered and re-used.

A pale, solvent-refined mineral oil, Calol Engine Oil—8 is exceptionally stable and is always uniform. It has a low pour-point, assuring good distribution and complete lubrication of bearing surfaces in cold weather.


SUITABLE FOR VARIOUS SPEEDS AND MINIMUM CLEARANCES
SPLASH LUBRICATED, HIGH SPEED ANTI-FRICTION BEARING
WIDE USE RANGE IN ALL OPERATING CONDITIONS
MAY BE FILTERED AND RE-USED IN CIRCULATING SYSTEMS, HYDRAULIC SYSTEMS OR APPLIED BY ANY TYPE OILER
LOW POUR-POINT ASSURES EFFICIENT LUBRICATION IN LOW TEMPERATURES

There is a Calol Product to meet every industrial lubrication problem. For information, write Standard of California, 225 Bush Street, San Francisco 20, California.

FOR EVERY JOB A **STANDARD OF CALIFORNIA** TEST-PROVED PRODUCT



Ask for Bulletin 4-A

which explains that ATLAS Hydraulic Damper Regulators are low in cost when compared with the value of the fuel they save. Easy to install. Available in types to suit practically any type of boiler.

ATLAS Damper Regulators

assure best maintenance of correct steam pressures.

For LOW PRESSURE..... WE RECOMMEND .....No. 501
For MEDIUM PRESSURE... WE RECOMMEND .....No. 502
For HIGH PRESSURE..... WE RECOMMEND .....No. 503

No. 501 is suitable for automatically regulating drafts of vapor or low pressure steam heating boilers. Can be adjusted to operate at any steam pressure up to 25 pounds.

No. 502 is the regulator pictured above. For boiler pressures up to 150 pounds. Will move damper on boiler pressure changes of ¼ pound.

No. 503 has a Cast Iron Base construction for boiler pressures up to 250 pounds; Cast Steel Base construction for boiler pressures up to 400 pounds. Will move damper on ½ pound boiler pressure variations.

AUTOMATIC • HYDRAULIC • SENSITIVE

Water pressure is made to act automatically on a piston which is connected to draft doors or dampers by chain. Ample power is thus available for moving the heaviest doors or dampers. At the same time the control piston responds to slightest variations in steam pressure so that uniform pressure is maintained through closest adjustment of dampers and a resulting steady rate of combustion.

Proper and automatic adjustment of drafts and dampers keeps CO_2 where it *should* be. CO is avoided. Fuel is saved and flue gas temperatures are kept down where they belong for maximum operating efficiency.

On forced draft boilers ATLAS Regulators may be arranged to control fan speed. From the fan they may be made to indirectly regulate the feed rate of the stokers.

ATLAS VALVE COMPANY
REGULATING VALVES FOR EVERY SERVICE

Specialists in Regulation for Nearly a Half Century

291 South St., Newark 5, N. J.

Representatives in Principal Cities

☐ Please send complete information on ATLAS Damper Regulators. Also please send information on the following ATLAS products—

☐ Campbell Boiler Feed Water Regulators
☐ Temperature Regulators
☐ Reducing Valves
☐ Exhaust Control Systems
☐ Pressure Regulators
☐ Pump Governors
☐ Float Valves
☐ Oil Control Cocks
☐ Humidity Controllers
☐ Thermostats
☐ Balanced Valves
☐ Control Valves

types of electric appliances and manufacture of new postwar products by the Mansfield, Ohio, and East Springfield, Mass., Electric Appliance Division plants of the Westinghouse Electric Corp. has been announced by A. W. Robertson, chairman.

Dollar volume in excess of $110,000,000 annually is anticipated from the increased sale of the 23 different kinds of electric appliances marketed before the war and from new products, which will include home and farm freezers,, automatic clothes dryers, steam irons, food mixers and additions to the line of vacuum cleaners, Mr. Robertson revealed following a meeting of the company's Board of Directors.

In the first full year of unrestricted appliance production, Westinghouse looks for dollar sales of electric appliances 138 per cent above those of 1941.

Of the $11,500,000 total expansion costs, $6,500,000 will be spent at the Mansfield Works and $5,000,000 at the Springfield plant. The largest expenditure in each factory will be for machine tools and capital equipment, estimated at $3,100,000 for the Mansfield plant and $2,750,000 for Springfield.

New buildings and additions to existing buildings will cost approximately $2,153,000 at Mansfield and will provide an additional 400,000 sq ft of floor space. The Springfield expenditure will be about $1,250,000 and will add 270,000 sq ft of floor space.

Plant requirements, including the cost of machine tools, conveyors, test stands, jigs and fixtures, will be $1,300,000 at Mansfield and $1,000,000 at Springfield.

General Motors Technical Center

ALFRED P. SLOAN, JR., chairman of General Motors, has announced what is believed to be an entirely new concept of industrial research through Corporation plans for what will be known as the General Motors Technical Center. This will consist of a group of buildings which will provide facilities to meet tomorrow's needs for the Corporation's research, advanced engineering, styling and process development sections of its general staff activities.

The various buildings comprising the General Motors Technical Center will be grouped around a central esplanade within which will be a seven-acre lake which in itself fills a useful purpose in the operations of the Center. The buildings will be of contemporary functional architecture. The Center will be erected on property one and one-half miles long and about half a mile wide covering approximately 350 acres, just outside of Detroit, Mich. Construction will start as soon as complete clearance on materials and labor can be obtained from proper Government agencies.

The cost of such a project will be substantial. General Motors Center will bring together at one place, and at a location physically closer to the manufacturing divisions, the research and experimental development facilities of the Corporation. This re-

Vogt

PRODUCTS ARE

★ DESIGNED to RAISE
★ OPERATING STANDARDS and
★ LOWER YOUR COSTS

Drop Forged for Safety and Economy under the Most Trying Conditions

Valves, Fittings and Flanges by Vogt—the choice of operating men everywhere for safe and sure regulation of the high pressure and high temperature liquids and gases used in modern process work.

High Operating Efficiencies and Low Maintenance Costs

More steam per dollar of investment—because Vogt steam generating equipment is designed and built to fit in with specific operating conditions. Vogt boilers are available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuels, as desired. Three-drum types can be supplied to fit any conditions of restricted installation space.

Meeting the Demands for Operating Security

Vogt has every facility for the fabrication of stills, towers, continuous rotary filters, filter presses, oil chilling machines, heat exchangers, etc., and these products are serving the petroleum industry around the world.

Vogt

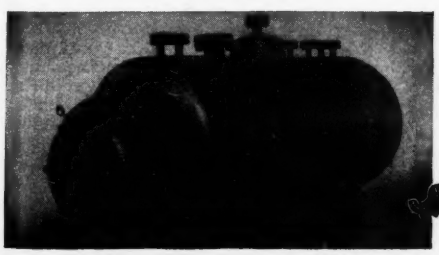
PRODUCTS

For Oil Refineries, Chemical Plants, Power Plants and Related Industries

HENRY VOGT MACHINE CO.

LOUISVILLE, KENTUCKY

NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS



To Combat Corrosion and Product Contamination

Process equipment made from special metals and alloys for the exacting service of the chemical plant is fabricated in our modern shops for many of the well known chemical companies.

Steps Tonnage Up and Costs Down

Our experience of more than 50 years in building profit-making ice and refrigerating machinery is at your command. We make complete units for ice and cold storage plants, packing plants, dairies, breweries, chemical plants, oil refineries, etc.

FULLER ROTARY COMPRESSORS AND VACUUM PUMPS
BUILT FOR CAPACITIES TO 1800 C.F.M. PRESSURES TO 125 LB. VACUUMS TO 29.00 IN. REFERRED TO 30 IN. BAROMETER
INSTALL FULLER ROTARIES
FULLER
FULLER COMPANY

"Spot"

Your Compressors . . . Air . . . Where and When Needed

WHY continue the old custom of compressing air at one central point, using large-size, high-pressure units, working on pressures equal to the highest demand from any part of the plant?

WHY compress air to a hundred pounds, or even higher, and then reduce it to lower pressures at the point of use?

WHY use long distance pipe lines, with consequent leaks, and pay the added expense to prevent such leaks?

WHY pay out in power bills the excessive cost of forcing air through long transmission lines? Friction losses are *direct* losses.

WHY take up valuable floor space and construct heavy, costly foundations?

WHY waste money when these objections, and many others, can be eliminated by installing Fuller Rotary Compressors?

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

Chicago 3 · 1144 Marquette Bldg.
San Francisco 4 · 421 Chancery Bldg.
Washington 5, D. C. · 618 Colorado Bldg.

No. 1 of a series

C-129

FULLER
PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

grouping of facilities will provide for a more rapid interchange of ideas among the technical personnel of the Corporation.

In addition to the new Center the Corporation also announced plans for extensive improvements in its present Proving Ground at Milford, Mich.

Certified Alloy Valve Co., has been formed as a new division of The Cooper Alloy Foundry Co., Hillside, N. J. Products will be sold through Cooper. This arrangement brings the entire metallurgical engineering and manufacturing process under one roof, including casting, heat-treating, machining and testing.

MANUFACTURERS' *Personals*

Harry R. Clarage succeeds the late Mr. R. R. Ware as president of Clarage Fan Co., Kalamazoo, Mich. He was elected to that office by the board of directors on June 26. At the same directors' meeting Robert A. Wasson was elected to the board, and chosen vice president and general manager. Both Mr. Clarage and Mr. Wasson have held important sales-engineering and administrative positions in the company since the early twenties. Mr. Clarage is the son of Charles Clarage, founder of the business. He was at one time manager of the company's New York office; later manager of the Detroit office.

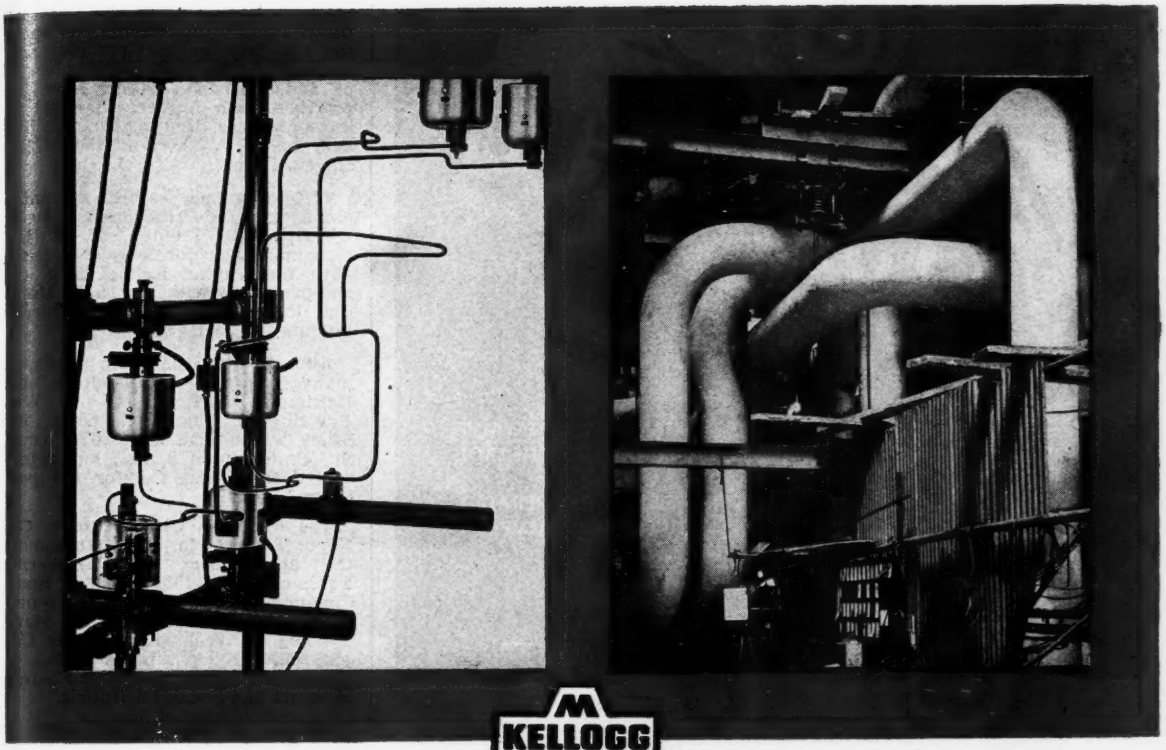
With plans for extensive coverage by St. Louis retail branch in the wide postwar stoker market, the Iron Fireman Manufacturing Co. has appointed Karl E. Saboe, industrial sales manager in Cleveland for the last 10 years as the branch's new manager.

C. Emery Nelson, Inc., 831 E. Hennepin Ave., Minneapolis 14, Minn., has been appointed agent for Kieley & Mueller, Inc., North Bergen, N. J., to cover the Minneapolis area.

S. Logan Kerr, fluid dynamicist and hydraulic engineer has become associated with Fischer & Porter Co., Hatboro, Pa., manufacturer of the rotameter for flow rate measurement and control. Mr. Kerr obtained his B.S. in mechanical engineering at the University of Pennsylvania in 1921 and a full M.E. degree in 1924. For many years he was hydraulic research engineer for I. P. Morris Co., later joining Baldwin-Southwark Corp. He became senior mechanical engineer on the Passamaquoddy Tidal Power project in 1935, and, since 1937 has been manager of the chemical engineering division of United Engineers and Constructors, Inc.

Howard E. Kingdon has been given the post of chief engineer and manager of the transformer department of The Eisler Engineering Co., Newark, N. J.

Donald S. Jackson, since 1939 a sales engineer for Peabody Engineering Corp. of New York, has been



KELLOGG

PIPING PROBLEMS
are Solved in Advance in the
KELLOGG LABORATORIES

Extremely accurate stress analysis of scale models, using electrical strain gauges, measuring load deflections to one millionth of an inch, enables Kellogg to furnish piping systems with complete assurance that they will perform as required when the plant is put in operation.

The "bugs" are thus found and eliminated even before the final drawings are allowed to go to the shop. This *design research* explains the acknowledged superiority of KELLOGG pipe installations. This is an exclusive Kellogg service available to consulting, power, process and marine engineers.

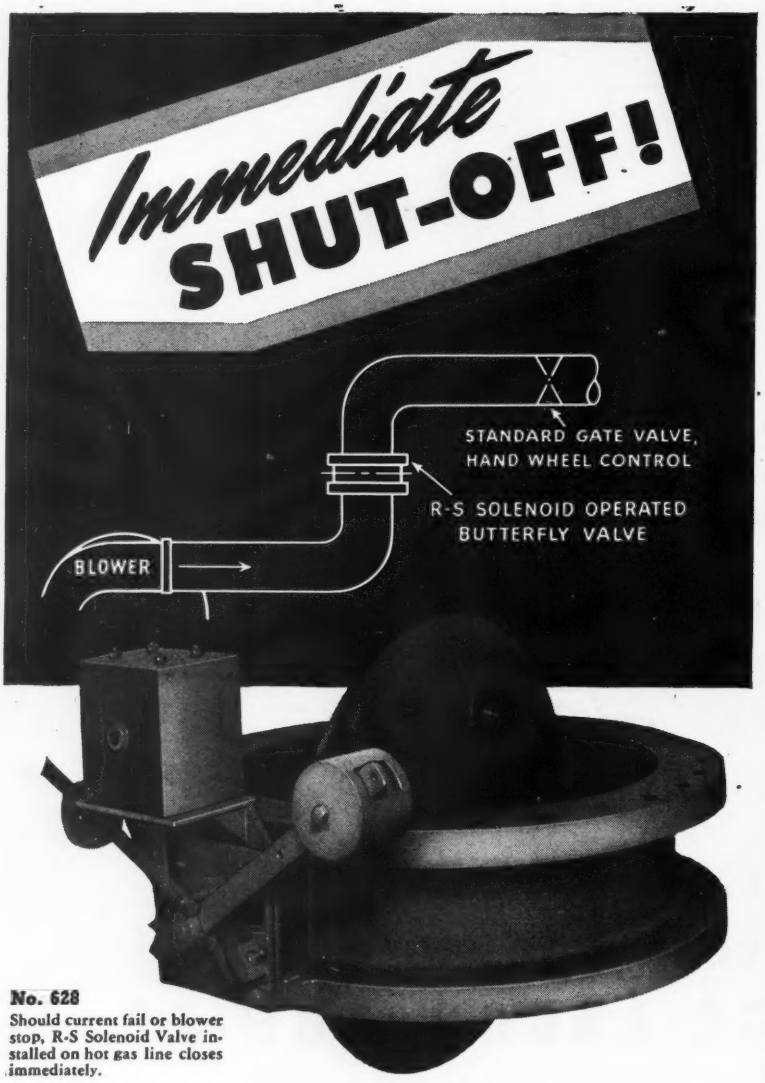
KELLOGG

"Masterflex" Prefabricated Piping Systems · **"Masterweld"** pressure vessels for Power, Refinery and Chemical Industries. Heat Exchangers. Pyrolytic and Catalytic Cracking Units, Hydroforming, Reforming, Dehydrogenation, Alkylation, Desulphurization. Thermal and Catalytic Polymerization Units · **JUIK** Processes for Lubricating Oil Plants. Plastic Refractories · Radial Brick Chimneys.

THE M. W. KELLOGG COMPANY · JERSEY CITY, NEW JERSEY · 225 BROADWAY, NEW YORK 7, N. Y.

REPRESENTATIVES

LOS ANGELES: 609 SOUTH GRAND · HOUSTON 2, TEXAS: 402 ESPERSON BLDG · TULSA: PHILTOWER BLDG.



No. 628
Should current fail or blower stop, R-S Solenoid Valve installed on hot gas line closes immediately.

The R-S Solenoid Trip Valve is used for emergency service. The solenoid can be arranged with the counterweight mechanism to open or close the valve and hold it there in one position or the other. If for any reason the solenoid functions, the latch is tripped, which permits the counterweight to open or close the valve by gravity. The assembly is suited to shut off the flow or to open a vent and requires manual reset. Can be constructed of any metal or alloy and in various sizes for air, gases, steam, oil, hydraulic and other services.

State your requirements and ask for Catalog No. 14-B.

R-S QUALITY PRODUCTS SINCE 1908

15 to 900 psi, for air, gas, steam, liquids and semi-solids.

VALVE DIVISION
R-S PRODUCTS CORPORATION
4535 Germantown Ave. • Philadelphia 44, Pa.

R-S Streamlined BUTTERFLY VALVES

made that company's sales agent for the State of Connecticut. Mr. Jackson also sells and services the products of the Enterprise Oil Burner Co. of San Francisco, taking over the representation formerly handled by the Enterprise Heating Service. His address is .P. O. Box 1945, New Haven, Conn.

T. D. Slingman has been appointed manager of Industrial Sales of Baldwin-Hill Co., Trenton, N. J. Mr. Slingman was formerly associated with the Dayton Rubber Mfg. Co. and previously with Fairbanks Morse Co., the Duriron Co. and Chicago Pneumatic Tool Co.

Allen B. Stiles has been appointed manager of the Philadelphia and Baltimore territory of the Wm. Powell Co., Cincinnati, Ohio. Mr. Stiles, whose office is at 1520 Locust St., Philadelphia 2, Pa., has represented the Crane Co. for the past several years.

The American District Steam Co., North Tonawanda, N. Y., announces the appointment of Engineering Equipment Co., 1532 Madison Road, Cincinnati 6, Ohio, as district representatives for Cincinnati and vicinity, and of Weeks Engineering Co., 4526 Olive St., St. Louis 8, Mo. as district representatives for Eastern Missouri and Southern Illinois.

Andrew H. Heywood has been appointed manager of the motor application department of the Westinghouse Electric Corp., East Pittsburgh, Pa. Mr. Heywood joined Westinghouse in 1926 after being graduated from Northeastern University, Boston, Mass. He served in industrial sales in Cincinnati, Ohio, for 10 years, then engaged in motor division sales activities until February, 1944, when he was appointed assistant manager of the department he will now head.

Gus H. Sample has been given the position of technical assistant to the director of engineering, Diesel division, of the American Locomotive Co. He will be located at Schenectady, N. Y. Mr. Sample is a graduate of Washington University with a B.S. degree in mechanical engineering. He is a member of the advisory board of the University of Washington Engineering School and has been employed in Diesel engineering work for the past 15 years.

Davidge H. Rowland has joined the staff of the Porcelain Insulator Corp., Lima, N. Y., as ceramic research engineer. In that capacity he will assume responsibility for the continuing development of Pinco Insulators and specialties.

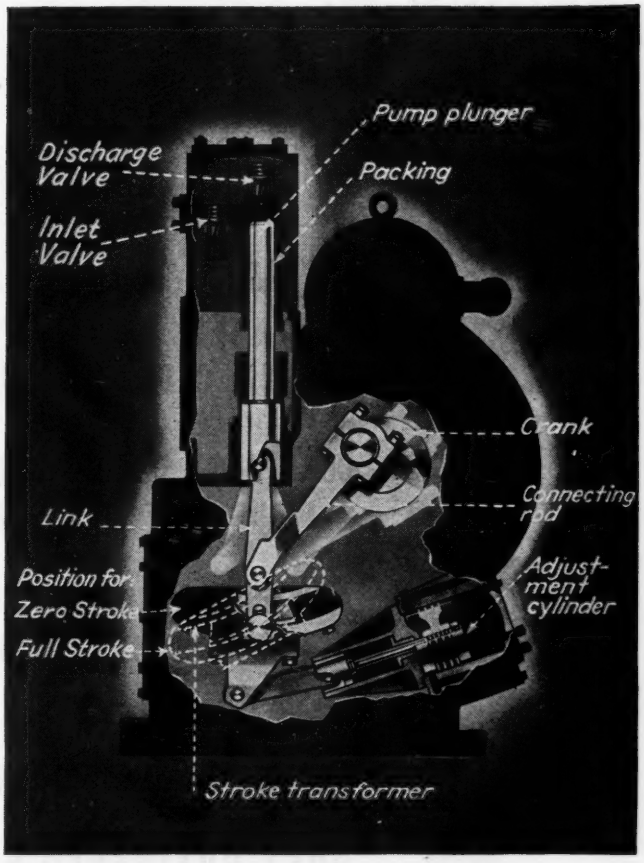
Appointment of G. A. Hyland as sales manager of the new Westinghouse aviation gas turbine division, South Philadelphia, Pa., was announced recently. Mr. Hyland succeeds W. F. Boyle, who has resigned. William A. Mechesney has been named manager of the contract negotiation department for the division.

Don H. Krey has been appointed sales manager and Elliott G. Johnson assistant sales manager of Homestead Valve Manufacturing Co., Coraopolis, Pa.

Here's why ALDRICH-GROFF "POWR-SAVR" PUMPS *actually* SAVE POWER

In medium and high pressure services—

- ***Boiler Feeding***
- ***Desuperheater Feeding***
- ***Process Charging***
- ***Pipe Line Pumping***
- ***Hydraulic Pressure***



Length of plunger stroke is governed by position of stroke transformer. At zero delivery, link has pendular motion and plunger does not move. As stroke transformer is rotated toward full delivery position (shown by dotted lines) vertical component of linkage increases until full stroke is obtained. Thus, no change in pump speed is required to vary pumping capacity.

Because these unique constant-speed variable-delivery pumps are designed to afford flexibility of capacity so that power consumption is practically proportional to delivery demands, substantial savings are assured. And, a self-contained dustproof lubrication system automatically provides oil supply under constant pressure to all bearing points —assuring continued high efficiency and low maintenance expense.

Where it pays to invest money for the efficient combustion of fuel and generation of power, or for economical process equipment, it is equally important and financially attractive to utilize power with a comparable degree of efficiency. It is the function of the ALDRICH-GROFF Pump to most efficiently utilize pumping power, particularly where variable rates of pumping are involved.

These pumps may be automatically or manually controlled from any remote point of control to provide stepless straight line variation ranging from zero to full delivery. They are adapted for operation with any standard automatic controller of the "air pilot" type responsive to variations in liquid level, flow, temperature, pressure or other desired conditions.

Now available in six standard sizes ranging up to 100 B.H.P. and for pressures up to 15,000 PSI, ALDRICH-GROFF Pumps are being increasingly used wherever power savings, extreme mechanical reliability and simple accurate control of delivery is important. Since being announced in 1939, more than 300 of these pumps have been placed in varied services and have established enviable performance records under severe and exacting service conditions.

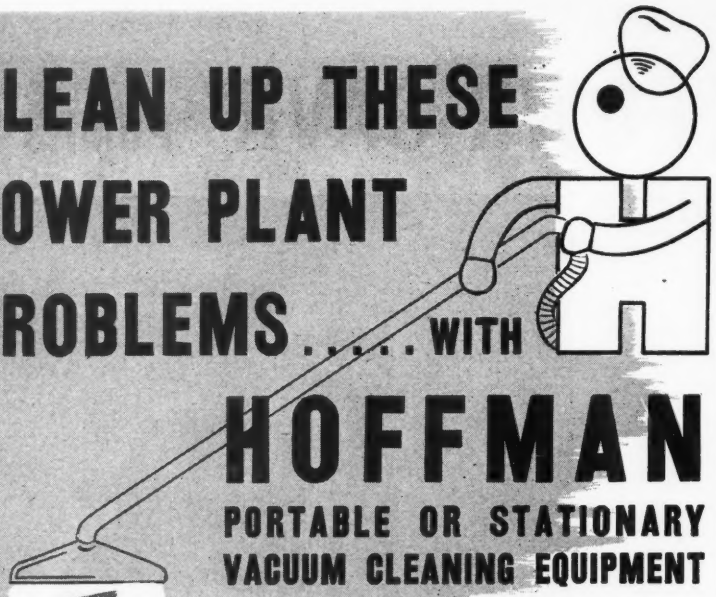
For a more detailed description of ALDRICH-GROFF principles write for Bulletin 65.

ALDRICH

THE ALDRICH PUMP CO. ALLENTOWN, PENNA.

REPRESENTATIVES: Birmingham • Bolivar, N. Y. • Boston • Chicago • Cincinnati • Cleveland • Denver • Detroit • Duluth • Houston • Los Angeles • New York City • Pittsburgh • Portland, Ore. • St. Louis • San Francisco • Seattle • Tulsa

CLEAN UP THESE POWER PLANT PROBLEMS..... WITH HOFFMAN



PORTABLE OR STATIONARY VACUUM CLEANING EQUIPMENT

DUST

COAL DUST DEPOSITS PRESENT SERIOUS EXPLOSION HAZARDS!

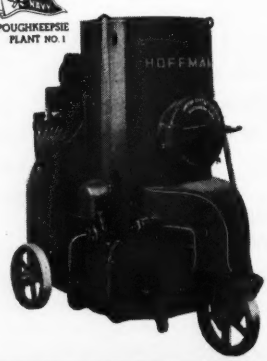
ASH DUST ACCUMULATIONS ARE A SERIOUS HEALTH HAZARD!

ORDINARY HAND CLEANING IS EXPENSIVE AND INEFFICIENT!

DUST SCATTERED BY HAND CLEANING DAMAGES DELICATE INSTRUMENTS!

Hoffman vacuum cleaning equipment is the economical solution to cleaning up coal dust and ash deposits. Hoffman has specialized for many years in power plant cleaning problems; Hoffman is standard equipment in many large power companies. A Hoffman stationary system — or heavy duty portable cleaner — accomplishes a more thorough cleaning job with less work, improves plant conditions, and prevents frequent repairs to many delicate instruments.

POUGHKEEPSIE PLANT NO. 1



➔ SEND FOR LITERATURE

U. S. HOFFMAN MACHINERY CORPORATION

AIR APPLIANCE DIVISION, 101 FOURTH AVE., NEW YORK 3, N. Y.

Ralph R. Brady, for the past three years manager of commercial engineering for the Westinghouse Lamp Division, has been appointed manager of electric discharge lamp sales. Mr. Brady will be responsible for unifying the Westinghouse effort in the sale and promotion of the entire family of electric discharge lamps except the Sterilamp bactericidal ultraviolet tube. The line includes fluorescent lamps, sunlamps, mercury vapor lamps and glowlamps. Working out of the Lamp Division's headquarters plant at Bloomfield, N. J., Mr. Brady will co-ordinate with the Division's district managers throughout the nation.

Taylor Instrument Companies has announced the following changes in the personnel of the sales organization: Raymond E. Olson has been made general sales manager to head up all of the various sales activities, both domestic and foreign. Functioning under Mr. Olson will be Frank S. Ward, new industrial sales manager. Assuming former duties of Mr. Olson as sales engineering manager will be Ralph E. Clarridge, who came with the Company in 1939 directly from Ohio State University. Assuming additional duties as commercial sales manager is W. Maben Griffith, whose department has charge of the sale of such well known consumer items as household thermometers, barometers, compasses and medical instruments.

Appointment of H. B. Leidy as manager of the Middle Atlantic District manufacturing and repair department of the Westinghouse Electric Corp. has recently been announced. R. J. Miller, who had been acting manager of the department, has been transferred to Emeryville, Calif., as assistant manager of the Pacific Coast District manufacturing and repair department. H. E. MacArthur, formerly foreman of the Newark, N. J., M. & R. plants, has been made manager of the Huntington, W. Va., branch.

Cutler-Hammer, Inc., of Milwaukee, Wis., announces the appointment of F. A. Wright as assistant general sales manager. Mr. Wright has been associated with Cutler-Hammer since 1927.

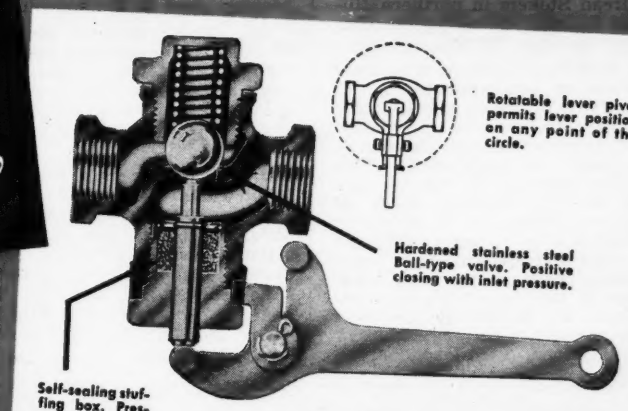
C. W. Guyatt, formerly chief industrial engineer, American Steel and Wire Company, has been appointed assistant to C. D. King, chairman of operating committees for United States Steel Corp. of Delaware. Mr. Guyatt will be located in Pittsburgh and will assist Mr. King in the establishment of production standards for all U. S. Steel subsidiary manufacturing companies.

Reliance Electric & Engineering Co., Cleveland, Ohio, announces two personnel changes: Fred E. Harrell, chief engineer for the past two years, has been appointed general works manager, succeeding S. B. Taylor, who has resigned as manufacturing vice president but will remain a member of the board of directors. William R. Hough, product development engineer, has been named chief engineer succeeding Harrell.

American Engineering Co., Philadelphia, announces the appointment of the Mid-West Heat Service, 3336 Franklin Blvd., Chicago 24, Ill., to

Will this valve simplify many control problems?

INVESTIGATE THE MANY POSSIBLE APPLICATIONS OF THE TRADE MARK LESLIE REG. U. S. PAT. OFF.


Rotatable lever pivot permits lever position on any point of the circle.
Hardened stainless steel Ball-type valve. Positive closing with inlet pressure.
Self-sealing stuffing box. Pressure-sealed during flow.

TYPE BA AIR OPERATING VALVE

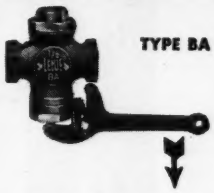
quick—acting AIR-OPERATING VALVE

TYPE **BA** *VALVE*

This self-sealing, ball type, air operating valve can be opened or closed instantly from almost any position and has a wide field of use in industry. They are made with cast iron bodies, integral seating surfaces, screwed connections, and in sizes ¼", ⅜" and ½". The type BA valve is fitted with a hand opening lever and a rotatable pivot so that the lever can be located in any position and opened with either horizontal or vertical pull. Operating pressures up to 200 p.s.i. are recommended. The ball type valve offers many advantages and will not collect dirt or foreign matter, closes with the inlet pressure and always finds a tight seat. The stuffing box is not accessible to tampering or adjustment and is self-packed by the operating pressure when the valve is open, permitting flow.

TYPE BA

Showing lever in position for parallel pull



TYPE BA

Showing lever in position for right-angle pull

TYPE BAC

Showing Cam-type Indicating lever raised—valve open

TYPE BAC

Cam-type Indicating lever down. Valve closed

TYPE **BAC** *VALVE*

The Type BA valve can be fitted with a cam operated lever (Type BAC) permitting instantaneous valve opening or closing by throwing the lever in the desired drection. The cam construction holds the lever in the position thrown until returned manually to the original position. The yoke supporting the lever can be rotated around the valve bonnet to any desired location. Enlarged lever end provides easy visual check on inner valve position.

YOU CAN BUY THIS VALVE FROM THESE AGENTS

BALTIMORE 2, MD. Conrad L. Stein & Co.
BOSTON, MASS. H. F. Eastman
BRIDGEPORT 3, CONN. William P. Little
CHICAGO 47, ILL. Lietz Engineering Co.
CLEVELAND, OHIO W. M. Wilson
DETROIT 26, MICH. Lloyd R. Leatherman
HOUSTON 2, TEX. Gulf Engineering Co.
KANSAS CITY 6, MO. Mooney Eng. Co.
LOS ANGELES 15, CAL. Adolf Fresse Corp.
LOUISVILLE 2, KY. John Zimmerman
NEW ORLEANS 13, LA. Gulf Engineering Co., Inc.
NEW YORK 7, N. Y. J. H. Fahlinger
PHILADELPHIA 30, PA. Edwin Elliot & Co.
PITTSBURGH 22, PA. Harold G. Jones Co.
PORTLAND 4, ORE. John H. Marvin Co.
PROVIDENCE 5, R. I. Paul A. Morrison
RICHMOND 1, VA. Frank Howell Company
ROCHESTER 7, N. Y. Weitz & Kronzer, Inc.
RUTHERFORD, N. J. Frank D. Riggio Co.
SAN FRANCISCO 3, CAL. Frank E. Witte Co.
SEATTLE 4, WASH. John H. Marvin Co.
ST. LOUIS 12, MO. Bruce Greaves
SYRACUSE, N. Y. G. L. Biggs (Fayetteville)
TROY, N. Y. C. H. Wilson
WILKES-BARRE, PA. W. H. Nicholson & Co.
YOUNGSTOWN 5, OHIO Industrial Sales & Supply Co.

ESTABLISHED 1900
LESLIE
REGULATING VALVES
LESLIE-TYFON WHISTLES

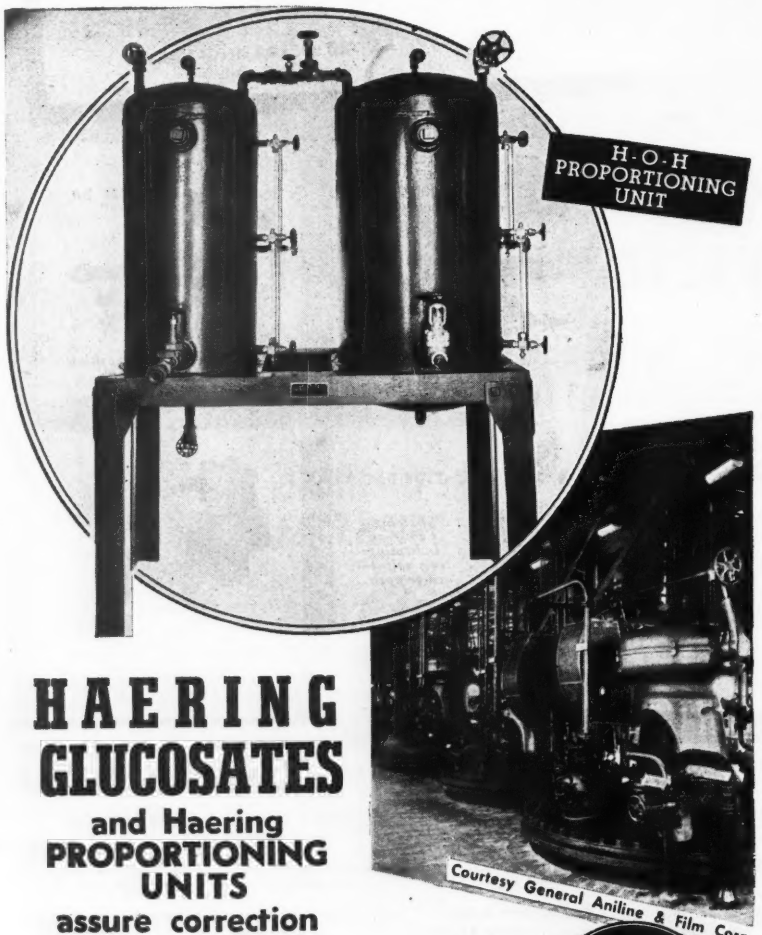
LESLIE CO. • LYNDHURST • NEW JERSEY

represent the AE-Taylor and AE Perfect Spread Stokers in northern Illinois and Indiana, including the Chicago metropolitan district.

Link-Belt Co. of Chicago announces the following appointments: A. C. Fellinger to the position of sales manager, power transmission machinery, with headquarters at the Company's Ewart plant in Indianapolis. This change is made to fill the vacancy caused by the utimely death of C. Walter Spalding. H. F. R. Weber as divisional sales manager, will head up the sale and application of Link-Belt silent chain drives, with headquarters at the Ewart plant in Indianapolis. G. H. Woody continues as sales manager of the ball and roller bearing division, with headquarters at the Company's ball and roller bearing plant in Indianapolis.

The C. H. Wheeler Mfg. Co. of Philadelphia, announces the appointment of T. S. Ryan as the California representative of the Company. He is located at 215 Rialto Building, Mission & New Montgomery Streets, San Francisco 5, California.

J. Warren Roberts has been appointed branch manager of the Allis-Chalmers office in Chattanooga, Tenn. Prior to joining the Allis-Chalmers Atlanta district office in 1941, Mr. Roberts was employed by the Nashville Railway and Light Co., Tennessee Electric Power Co., Allied Engineers, Inc., and Electric Power Board of Chattanooga.



HAERING
GLUCOSATES
and Haering
PROPORTIONING
UNITS
assure correction
and control of
CORROSION,
SCALE, ALGAE
in Industrial Plants

WRITE FOR
"H-O-H
WATER
STUDIES"

WE
READ
WATER

D. W. HAERING & CO., Inc.
GENERAL OFFICES:
205 West Wacker Drive, Chicago 6, Ill.

Miss Edith Clarke, first woman to receive an electrical engineering degree from Massachusetts Institute of Technology and an expert in electric power systems, retired July 31 from General Electric after 26 years of employment with the company. Miss Clarke came to G. E. in 1919 as a member of the Turbine Engineering Department and in 1921 had a leave of absence to go to Turkey as professor of physics at the Constantinople Woman's College. She returned to Central Station Engineering in 1922 and since that time has done outstanding work in the electrical engineering field. She is well known for her original contributions to symmetrical component and circuit analysis theory as well as for her outstanding contributions to the subject of long distance power transmission.

At a recent meeting of the board of directors of The Dampney Company of America, Hyde Park, Massachusetts, John W. Laverack, vice president and treasurer was named president. He succeeds Clarence J. Hunter who becomes chairman of the board and technical director for special concentration on research and development and extension of the work the Company in its field of technical coatings for power and mechanical operation equipment. President Laverack is the son of the late William H. Laverack who was Dampney Company's president for 14 years before his death in 1944.

E. G. Cross has recently been appointed supervisor of the production planning and control department of the Crocker-Wheeler Division, Joshua Hendy Iron Works at Ampere, N. J. Prior to his association with Crocker-Wheeler, Mr. Cross had already gained a wide experience in the industrial management field. His background covers managerial positions in methods and procedures, contracting, accounting, material control, production control and production.

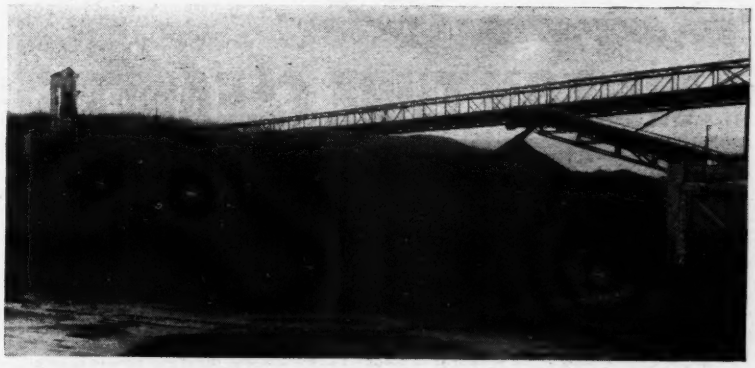
Formation of a new turbine section at the Fitchburg, Mass., plant—known as the Fitchburg section, turbine division—has been announced by General Electric Co. L. D. Whitescarver, formerly general assistant to the sales manager of the Lynn, Mass., section, has been named manager of sales of the new Fitchburg section. L. E. Newman of the turbine division, Schenectady, succeeds Whitescarver at Lynn. The Fitchburg section will be responsible for the sale of turbine products manufactured in that plant.

Hobart C. Ramsey, executive vice president of Worthington Pump and Machinery Corp., has in addition, been named president of the Ransome Machinery Co., subsidiary of Worthington in Dunellen, N. J., where concrete mixers and road pavers are made. The appointment became effective August 1. Also named vice president and general manager of the Dunellen plant is J. G. Ten Eyck, who has just completed five years active service with the U. S. Navy and who was formerly president of the industrial engineering firm of Ten Eyck, Inc. Kenneth W. Horsman, formerly superintendent of welding and steel fabrication at the Worthington Harrison Works, has been transferred to Ransome as Works Manager. Newly elected directors of the Ransome Co.

Mine-to-Power-House Conveyor Cuts Coal Handling Costs • • •

Above: Pennsylvania Electric Co. steam-electric generating station at Seward, Pa. Belt conveyor No. 1 is shown, also the inclined steel apron conveyor that feeds it.

Below is a view of reserve coal pile, showing conveyor No. 1 and stocking-out conveyor.



• Savings in handling costs and increased coal storage capacity are being realized by Pennsylvania Electric Company, by the use of a Link-Belt belt conveyor system operating between mine tipple and power house or stock pile.

Replacing thirty-eight railroad cars, two steam locomotives and a locomotive crane, the new system requires only the aid of a bulldozer in stocking-out and reclaiming the coal from reserve ground storage pile.

Coal of 6-inch size and under (with occasional larger lumps) is carried at the rate of 250 tons an hour at 450 ft. per minute. The coal comes from a company mine 800 ft. from the power house. A 24" x 440' centers belt conveyor takes the coal to a Bradford type breaker and cleaner. Another conveyor 24" x 347' centers takes the crushed coal to belt conveyor and tripper extending over length of power house coal bunker. A 24" x 58' long belt conveyor on an incline, mounted on a steel boom, is used for stocking-out coal on ground. Link-Belt belt conveyor equipment provides a practical way to increase handling capacity and lower costs. Let us send you Folder 2087 on this installation, also Folder 1915 on Link-Belt belt conveyor idlers.

LINK-BELT

COAL AND ASHES HANDLING EQUIPMENT

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8.

Offices in principal cities. 9959

are Ten Eyck and Carl F. Oechsle, vice president in charge of sales.

Henry F. Dever has been elected president of the Brown Instrument Co., a wholly-owned subsidiary of the Minneapolis-Honeywell Regulator Co. Mr. Dever, who has been serving as vice president in charge of engineering for Minneapolis-Honeywell, succeeds Charles B. Sweatt as president of Brown. The latter, vice president and director of Minneapolis-Honeywell, was withdrawn from Brown and will henceforth devote his entire attention to supervision of the expanded sales activities of the Honeywell organization and its subsidiaries.

James De Kiep has been appointed chief engineer in charge of electrical and mechanical design and development by Electric Machinery Mfg. Co., Minneapolis, Minn. Mr. De Kiep was formerly manager of the a-c motor engineering department at Westinghouse Electric Corp., East Pittsburgh.

Henry E. MacArthur, has been chosen by Westinghouse Electric Corp. as manager of the manufacturing and repair department at Huntington, West Virginia. Mr. MacArthur joined Westinghouse in 1929, he worked as tester in the East Pittsburgh Works until 1935, when he was transferred to the New York service department as a field engineer. He went to the engineering and service department in that city as a service engineer in 1940, and to the manufacturing and repair department of the Newark Plant in 1942 as maintenance foreman. From this post he goes to his new assignment.

James L. Ray, widely known steam and gas-turbine engineer, will head the Joshua Hendy Iron Works' gas and steam-turbine engineering department in San Francisco and supervise the considerable enlargement of its technical staff.

Establishment of an export department in its machine division and appointment of Ward Dougherty as export manager is announced by The Osborn Manuafacturing Co., of Cleveland. Mr. Dougherty, a veteran of 25 years of service with the company, was formerly manager of the machine division contract department.

France Packing Co., Philadelphia, announces that E. A. France, son of Adam Warren France, who patented France Metallic Packing and founded the business nearly fifty years ago, is now president and general manager. J. C. Allen is the new treasurer. Both Mr. France and Mr. Allen have been active in the manufacture of metallic packing for many years.

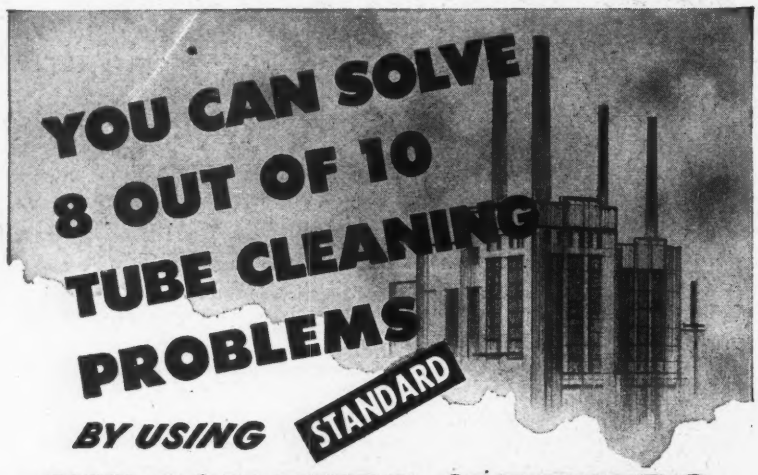
Dr. L. B. Arnold, Jr., has joined the staff of Arthur D. Little, Inc., Cambridge, Mass., industrial research organization. Dr. Arnold was previously in the organic chemicals and rayon departments of E. I. du Pont de Nemours & Co., and more recently an assistant director of the chemistry division of the Metallurgical Laboratory at Chicago, Ill.

John C. Sykora has been elected vice-president and director of sales for all divisions of the Portable Products Corp., Pittsburgh. Mr. Sykora will direct activities for the Corporation from newly established headquarters in the Woolworth Building, New York City. Included in the five units of Portable Products Corporation are C. J. Tagliabue manufacturing division, precision instruments, Brooklyn; Coldwell Lawnmower and Philadelphia Lawnmower manufacturing divisions, Newburgh, New York; Paul & Beekman manufacturing division, precision metal stampings, Philadelphia, and Strauss manufacturing division, safety equipment, Pittsburgh.

Appointment of Adolph G. Hochbaum as managing director for exports to U. S. S. R. and general sales representative for Central and Eastern European countries, has been announced by The Baldwin Locomotive Works. He had been with Baldwin since January 1, 1939, handling various products for Russia.

Executive changes made recently by the Peabody Engineering Corp., 580 Fifth Avenue, New York, are: David P. Graham, assistant to the president, was made second vice president and a member of the board of directors. Charles B. Hill continues as first vice president. Clarence A. Snider, formerly secretary-treasurer, is now treasurer and H. Victor Crawford was elected secretary. These officers comprise the company's board of directors.

Harry A. Feldbush, formerly works manager of the Holyoke, Mass., plant of Worthington Pump and Machinery



WILSON TUBE CLEANERS

Yes, you can solve almost all tube cleaning problems without resorting to expensive or unusual equipment—if you use standard Wilson Tube Cleaners!

A recent survey shows that 80% to 90% of thousands of tube cleaning problems presented to Wilson Engineers can be solved easily when the right combination of Standard Wilson equipment is used.

You can choose a motor, cutter head, flexible shaft or other accessory from the complete line of Wilson Tube Cleaners, and assemble a cleaner that will help you get your tubes *cleaner, faster* and save you money as well as time.

A copy of the Wilson Tube Cleaners Check List will show you how to choose the right equipment. It contains a handy Tube Cleaner Selection Guide to help you pick the right motor, cutter head and accessory for any fouled tube condition. In addition there is a list of hints on maintenance and operation that will go a long way towards making your job pleasanter and your tube cleaners last longer.

Be prepared for tube cleaning emergencies. Send for your free copy of bulletin 75 today.

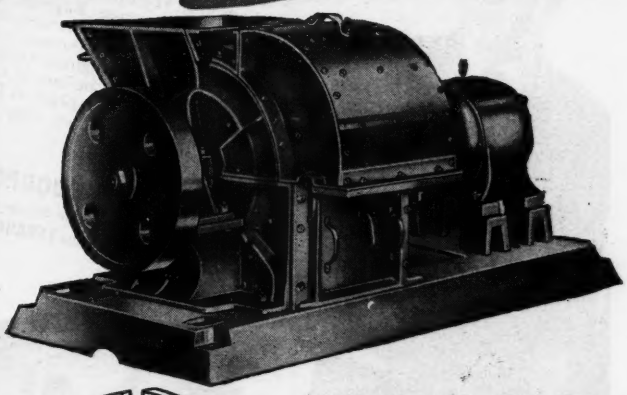
TW-692

THOMAS C. WILSON Inc.
21-11 44th AVENUE, LONG ISLAND CITY 1, NEW YORK

GREATER COMBUSTION EFFICIENCY with ANY GRADE OF COAL UNIFORMLY CRUSHED

The American Way

After installation of American Rolling Ring Crushers, power plant studies show total cost of crushing coal, including power, labor and depreciation costs, to be, in many cases, less than 1c per ton.



AMERICAN "S" Type RING CRUSHER

Shredder Rings of hardest manganese steel are a patented feature of American Rolling Ring Crushers exclusively. The twenty cutting teeth on the shredder rings revolving at terrific centrifugal force split the coal instead of crushing it, to prevent clogging and minimize unwanted sizes.

Without the use of shear pins or other safety devices, damage from metal contact is entirely eliminated by the deflecting action of the free swinging shredder rings.

American Rolling Ring Crushers split coal uniformly to exacting specifications in a wide range of sizes. Run of mine coal reduction is obtained in any degree of fineness—for stoker or pulverized coal firing—without subsequent screening.

This uniform reduction of coal provides, not only increases in normal operating efficiency from 2½% to 8%, but also increases combustion efficiency by at least 3% through reduction of ashpit and excess-air losses incurred in less uniform coal reduction.

Investigate American Rolling Ring Crushers for modernizing the fuel feed system in your boiler-room operation.

A few of the many power plants which have one or more American Rolling Ring Crushers installed:

Alabama Power Company
Indianapolis Power & Light Company
Central Illinois Light Company
Commonwealth Edison Company
John Morrell & Company
Pennsylvania Power Company
Carnegie-Illinois Steel Corporation
West Virginia Pulp & Paper Company
American Gas & Electric Company
Shell Petroleum Corporation

The informative, valuable booklet "Crushing Coal at Less Than 1c Per Ton" will be sent you upon request. Write for it now.

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

1429 MACKLIND AVE.
ST. LOUIS 10, MO.

HONAN-CRANE MEN Are Trained Oil Purification Engineers

Honan-Crane oil purification equipment is sold ONLY by trained Oil Purification Engineers—skilled technicians capable of making an intelligent analysis of any problem involving dirty or contaminated oils. These men are also capable of supervising the proper installation of Honan-Crane equipment to give you maximum oil purification protection against acids, sludges, abrasives, other damaging contamination.

Keeping oil clean pays big dividends in reduced maintenance and increased production in the operation of Turbines, Internal Combustion Engines, Hydraulics, Machine Tools, Compressors and other industrial equipment. Put this Honan-Crane Oil Purification Engineer to work on your problem—he will be one of the most important men in your plant. A Honan-Crane Engineer will call at your convenience. Write today.

HONAN-CRANE CORPORATION
Subsidiary of Houdaille-Hershey Corporation
301 Indianapolis Avenue LEBANON, INDIANA

Honan-Crane has had many years of experience in the engineering and building of oil purification equipment.

TEMPLETON RETURN STEAM TRAPS

for Pumping, Boiler Feeding, Draining, Heating and Vacuum Lines

Pumps Water at any temperature or pressure.

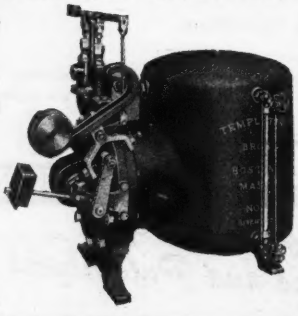
Open float cannot burst or waterlog.

Valves and Seat Bronze or Stainless Steel.

Sizes 1 in. to 4 in. inlet and outlet.

Capacity 2500 lbs. to 60,000 lbs. water discharge per hr.

Ask for catalogue and prices



TEMPLETON BROS., INC.
699 Main St. Walpole, Mass.

Corp., has been named vice president in charge of engineering for the entire Corporation. His duties cover engineering activities of all works and domestic subsidiary companies. His headquarters will be at the general offices in Harrison, N. J. Ralph M. Watson, formerly chief engineer of the centrifugal engineering division, has been appointed assistant to Mr. Feldbush.

Harvie L. Sykes, Jr., an illumination engineer for the Jersey Central Power and Light Co. since 1940, has joined the Middle Atlantic District of the Westinghouse Lamp Division as district engineer. Mr. Sykes will supervise lamp engineering contacts with industries, utilities and jobbers in Eastern Pennsylvania, Southern New Jersey, Delaware, Maryland, Virginia, West Virginia, Northern Kentucky, Northern North Carolina, Northern Tennessee and the District of Columbia.

F. J. Van Poppelen of Fairfield, Conn., has been appointed vice president of Salem Engineering Co., Salem, Ohio. For the past eleven years, Mr. Van Poppelen has filled various executive positions at the Remington Arms Co. of Bridgeport, Conn. During the last several years, he served as chief engineer of the military division for the same Company.

Appointment of Robert V. Lackner as field engineer for the Allis-Chalmers Mfg. Co.'s Pittsburgh district office was announced recently. Lackner will render service as field engineer to the steel and alloy industries in the Pittsburgh area.

C. D. Belt and Co., 1530 16th St., Denver, Colo., have been appointed district sales representatives for Allen-Bradley Co., Milwaukee, Wis., manufacturers of solenoid motor controls. The Belt organization will cover the state of Colorado, the panhandle of Nebraska, and the southern part of Wyoming.

James D. Sawyer, formerly a supervisor in the power plant section of the Curtiss-Wright Corp.'s research laboratory in Buffalo, has been elected vice president and chief engineer of the Buffalo Turbine Corp., a new company which is engaged in research into gas turbines for eventual civilian use.

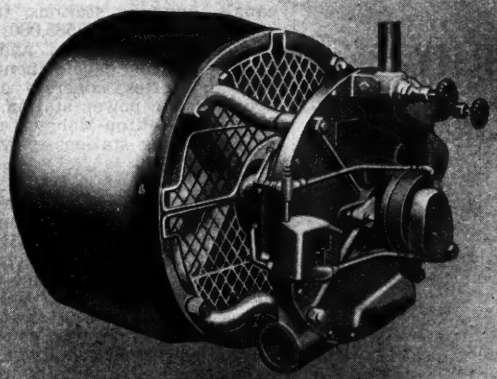
Stanley E. Johnson, general sales manager of The Cooper-Bessemer Corp., has been elected a vice president and member of the board of directors and Charles G. Cooper, manager of the company's Washington office, also elected to membership on the board.

NEWS *from* THE FIELD

Bureau of Reclamation —Postwar Projects

BUREAU OF RECLAMATION, Department of Interior, Washington, D. C., has scheduled a large number of

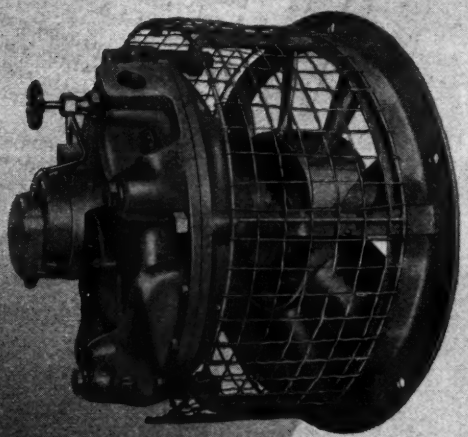
WING



WING TURBINE DRIVEN BLOWERS
Type K
For Brickwall Mounting

Generally used for Stoker or Bagasse Firing where casing is cemented into Boiler Wall

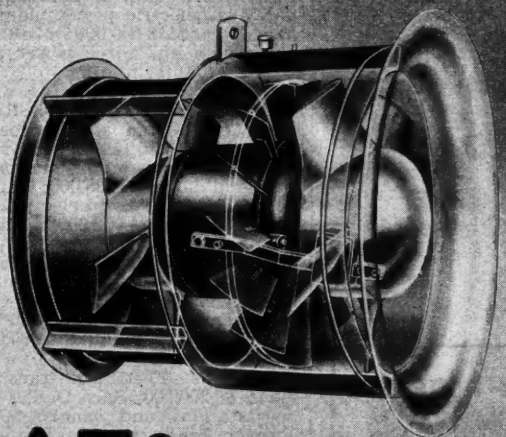
Wing pioneered in forced-draft turbine blowers over a third of a century ago. Today Wing Turbine Blowers are in use in thousands of installations in many varied industries. They are simple and rugged in construction, quiet and dependable in operation. Oil-free exhaust can be used for heating, process or feed water.



WING TURBINE DRIVEN BLOWERS
Type R
For Horizontal or Vertical Mounting on Wind Boxes or Air Ducts

Generally used for Oil Firing on Marine and Stationary Boilers, for Marine Ventilation, etc.

Ideal where use can be made of exhaust steam or where electricity is not available. Flexible capacity regulation by throttling steam to turbine—manually by hand valve or automatically by combustion control. Prompt shipments (no waiting for motors).



WING MOTOR DRIVEN BLOWERS
TYPE COM (TWO STAGE)
TYPE EMD (SINGLE STAGE)

Wing Motor Driven Blowers are axial flow forced draft blowers of simple, rugged construction, compact design and highest efficiency. Type EMD has capacities up to 50,000 CFM with statics to 5". Type COM can handle statics up to 30" on special designs.

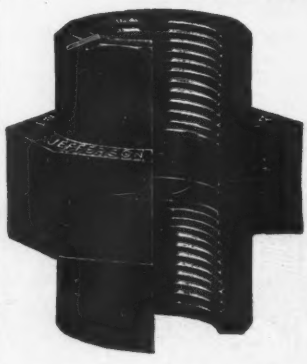
Write for Bulletin SW-1

L. J. Wing Mfg. Co.

153 W. 14th St., New York 11, N. Y.
Factories: Newark, N. J. and Montreal, Canada

Wing AXIAL FLOW BLOWERS

Specify
SONDERGLASS
FOR BULLS-EYE VISIBILITY
AT BOILER WATER LINES
IF the operator can see the boiler gauge he can read the water level instantly with Reflecting SONDERGLASS.
THIS improved gauge glass has a red and white enameled back that bulls-eyes the waterline; makes it visible even in dark locations.
ALSO lessens danger of ugly cuts or blinded eyes from flying glass. Its extra strength comes from the use of two semi-metallic substances with different degrees of expansion. That explains why Sonderglass is commonly called "the Unbreakable Gauge Glass."
ORDER FROM YOUR DEALER OR DIRECTLY FROM US
A. W. Chesterton Co.
64 INDIA STREET
BOSTON, MASS.
Distributors in Principal Cities



The Feature of the RECESSED BRASS SEAT in the

JEFFERSON UNION

makes it unique

It is cut from seamless drawn tubing—free from all casting defects—sound and uniform always! It cannot be dislodged by a pipe end screwed in too far.

JEFFERSON UNION CO.

601 West 26th St., New York 1, N. Y.

Factories at Lexington 73, Mass., and Lockport, N. Y.

postwar projects in different States to be carried out in the months to come, when appropriations are made available. Several are on the construction calendar for early development. The sum total involves many millions of dollars. Among the important projects are:

Arizona—Davis dam, earth dam and hydroelectric power development, $41,200,000; Gila-Mesa unit, canals, pumping stations, transmission lines, etc., $3,585,000; Bridge Canyon, concrete dam and hydroelectric power development, $207,432,000; Buttes, concrete dam and hydroelectric power station, $7,000,000; Gila-Wellton-Mohawk unit, canals, pumping stations, power lines, etc., $9,420,000.

California — All - American Canal, canals, pumping stations, transmission lines, drains, etc., $31,817,000; Central Valley (Friant, Kern, Delta, Mendota, etc.) canals and pumping plants, power lines, $54,510,000; Kings River, concrete and earth dams, and hydroelectric power plant, $53,000,000; American River, Folsom dam, concrete dam and hydroelectric power plant, $26,000,000; Jacksonville, reservoir, concrete dam and hydroelectric power station, $13,326,000; New Melones, reservoir, concrete dam, hydroelectric power development, $22,256,000; Iron Canyon, canals and pumping plants, $31,000,000; Bullards Bar Reservoir, concrete dam and hydroelectric power plant, $32,000,000; Table Mountain, concrete dam and hydroelectric power development, $55,000,000.

Colorado — Colorado - Big Thompson, dams, canals and generating station, $38,939,000; Blue River-South Platte, earth and concrete dams, canal, hydroelectric power plant, tunnels, etc., $148,000,000; Montrose, earth dam and three power plants, $3,850,000.

Idaho — Boise - Anderson Ranch Dam, earth dam and hydroelectric power plant, $5,154,000; Boyse-Payette Division, pumping stations, canals and dams, $3,298,000; Palisades, earth dam and hydroelectric power plant, etc., $24,000,000; Mountain Home, pumping plants, earth dams and canals, $90,000,000; Cabinet Gorge, concrete dam and hydroelectric power plant, $12,600,000; Oneida, earth and concrete dam, and hydroelectric power plant, $15,000,000.

Montana—Fort Peck, transmission lines, $6,200,000; Saco Divide, pumping stations and canals, $692,000; Canyon Ferry, concrete dam and hydroelectric power plant, $11,405,000; Glasgow Bench, pumping stations, canals, etc., $4,788,000; Hardin and Yellowtail Reservoirs, concrete dam, canals and hydroelectric power plant, $34,014,000; Hungry Horse-Kalispell, concrete dam, canals, hydroelectric power development, $40,000,000; Missouri Souris-Montana Division, pumping stations, canals, etc., $29,030,000.

Nebraska — Bostwick, earth dam, canals, hydroelectric power plant, $24,413,000; Well units, five wells, pumping stations and canals, $1,147,000.

Union Finished Steel Roller Chain is manufactured in all standard sizes from ⅜" to 2½" pitch, in single and multiple strands.

BACK OF EVERY PITCH

☆ The headwork and control with which an old master baffles the opposition is not found in any amateur who pitches a game now and then. Back of every pitch are years of study, practice and experience.

Every pitch of Union Chain has a similar background of specialization. Union manufactures a complete line of steel chain, sprockets and flexible couplings for power transmission and for the mechanical handling of material. By concentrating all of our talents on the manufacture of this one line, we have achieved a quality of product, on which we invite your opinion. Perhaps it will be . . . "One, Two, Three Strikes and you're out of trouble when you turn to Union Chain."

The Union Chain and Manufacturing Company, Sandusky, Ohio, U. S. A.

Union Chains for Every Application

Drive and Conveying Chains and Sprockets

- Bridge Chain
- Combination Malleable Iron and Steel Chain
- HB (hardened bearing) type chain
- BP (bar and pin) type chain

★

Finished Steel Roller Chains and Sprockets

- All manufacturer's standard sizes ¼ in. to 2 in. pitch
- Single and Multiple Strands
- Extended Pitch Series in sizes 1¼ in. to 4 in. pitch

★

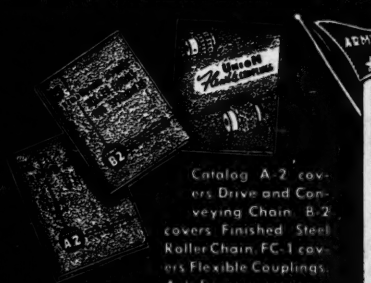
Silent Chain and Sprockets

- All sizes ¼ in. to 11½ in. pitch

★

Flexible Couplings

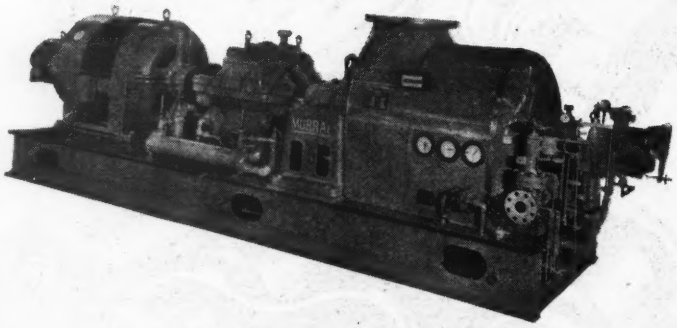
- Roller chain type
- Silent chain type



Catalog A-2 covers Drive and Conveying Chain. B-2 covers Finished Steel Roller Chain. FC-1 covers Flexible Couplings. Ask for your copies.

UNION CHAINS

MURRAY
TURBINE-GENERATORS



500 KW — PACKAGE TYPE

The unit shown was designed to deliver 500 KW alternating current on steam at 285 lb Gauge initial pressure, 700 degrees F. total temperature and 27 inches vacuum. Provided with a rigid structural steel baseplate, and with all service connections except generator leads above the floor line, the machine can be handled as a unit and installed with a minimum of preparation.

While "Package Type" units were furnished for export for installation in remote areas not previously supplied with power, the design can be utilized for small industrial plants for main or standby power supply.

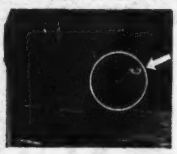
MURRAY also produces

Mechanical Drive Turbines—Horizontal and Vertical
Reduction Gears
Steam Boilers

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA
BUILDERS OF STEAM POWER EQUIPMENT FOR THREE QUARTERS OF A CENTURY

"Boiler Repairs Reduced 75%"

writes user of **NATIONAL GIRTH SEAM PROTECTOR**



We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.
Von Platen-Fox Co.
Iron Mountain, Mich.

You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

NATIONAL BOILER PROTECTOR CO., 740 REIBOLD BLDG., DAYTON, OHIO

Nevada — Upper Truckee, earth dam, canals, hydroelectric power station, $5,535,000; Washoe Lake, earth dam, tunnels, canals and hydroelectric power plant, $5,200,000.

New Mexico—San Juan-Chama diversion, earth dams, canals and hydroelectric power plants, $15,968,000; Cliff Reservoir, concrete dam and hydroelectric power development, $9,500,000.

North Dakota—Heart River, pumping plant, canals and drains, $2,900,000.

Oregon—Debenger Gap, earth dam, canals and hydroelectric power development, $13,740,000; Crooked River (Ochoco) earth dam, canals and pumping station, $,1,680,000; Baker, earth dam, canals and pumping plants, $3,663,000.

South Dakota—Oahe, canals, and pumping stations, transmission lines, etc., $25,000,000.

Reconversion Aid

TO FACILITATE QUICK, easy reconversion inventories of industry's most widely used general purpose equipment, the Allis-Chalmers Mfg. Co. announces that it will soon begin to distribute a newly prepared reconversion inventory kit, covering centrifugal pumps, V-belt drives, and electric motors. Actual condition of this equipment is in many cases unknown in this early period of reconversion.

For about four years, throughout industry far greater emphasis has been placed on setting production records than on keeping maintenance records. Because much equipment has been worked during wartime three and four times as many hours a year as in peacetime, calendar age may mean nothing. Through necessity, much equipment has been misapplied, and repair has often depended on American ingenuity and baling wire.

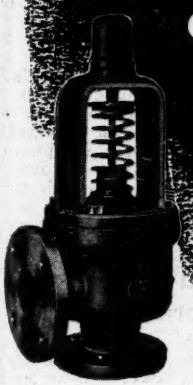
An extension of Allis-Chalmers' wartime aid-to-maintenance program, the kit will enable the user to determine the exact condition of each piece of existing equipment which is scheduled for peacetime production duty. Standards which generally apply to all makes of the same type of equipment determine which units are (1) okay as is, (2) need new parts, (3) will shortly require replacement, (4) need immediate replacement, (5) need reapplication, (6) are obsolete, or (7) may have parts of second or third-choice materials that were dictated by wartime shortages.

This kit, which will be distributed free, contains a set of three fact sheets, one for each type of unit, with suggestions for inventory procedure, and a set of three check lists which summarize the procedures and permit detailed appraisal of each unit.

Union Bag Expansion

DESIGN AND CONSTRUCTION of a pulp washing plant and power facilities for Union Bag and Paper Corp., to provide for expansion of its Savannah, Ga., plant from 800 to 1000 tons per day, is now under construction

When you need SAFETY or RELIEF VALVES you don't want...



FARRIS Safety Valve No. 2175. Full nozzle port, high lift, high capacity. Steam Separator Bell. For pressures to 600 lbs. at 750° F. Sizes ¾" to 6". Over-size outlet.

FARRIS Vapor or Liquid Service Valve No. 1775. For pressures up to 600 lbs. Sizes ¾" to 6". Enclosed spring, high lift, full port capacity. Available with pressure-tight cap; test lever; pop action.

We FARRIS Valve engineers and builders have been hard pressed to meet the war requirements of the government, its ships, and its war-production plants. But we have likewise exerted every effort to supply the needs of private industry during this national emergency. And nearly always we have *delivered* the FARRIS Safety or Relief Valve required . . . *when* and *where* it was needed.

Oh, yes — priority perplexities, material scarcities, and delivery delays have had us groggy, too! But we have held on to our perspective and vision, and they have enabled us to "deliver the goods." So when you need a safety or relief valve . . .

ask for a FARRIS!

When you specify a FARRIS Safety or Relief Valve you'll get GOOD DELIVERY — *and a lot more!*

- **You'll get a dependable valve, with every finished surface precision machined . . . for precision operation in the protection of your equipment.**
- **You'll get "precision alignment" of spring, stem, disc, guide, and seat . . . for reliable, trouble-free performance.**
- **Your FARRIS valve will have fewer parts . . . for reduced risk of failure.**
- **And it will have sturdy construction, with materials of superior strength and durability . . . for grueling service and long life.**

Farris

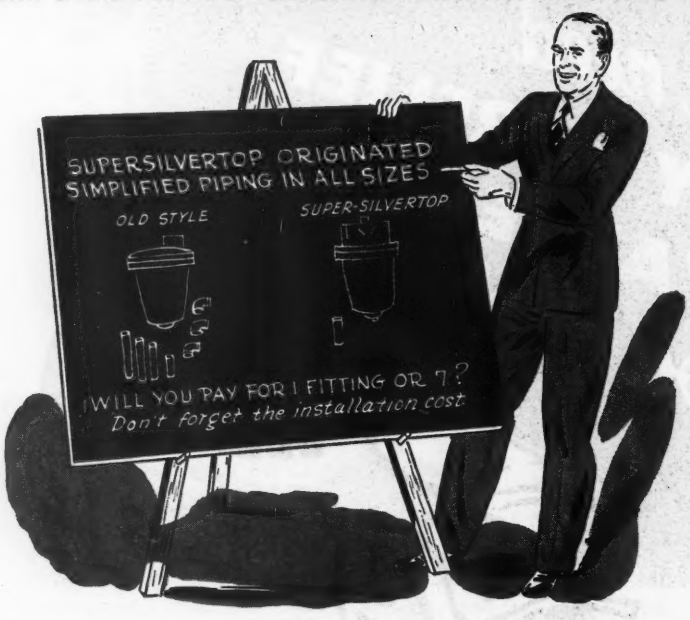
SAFETY and RELIEF VALVES

***Among the complete lines of FARRIS Safety and Relief Valves there must be the very valve you need — or we'll custom build one to meet your particular requirements!* Why not write today for our Bulletin?**

380 COMMERCIAL AVE. **PALISADES PARK, N. J.**

Chalk Talk No. 3

ON POSTWAR STEAM TRAP ECONOMY

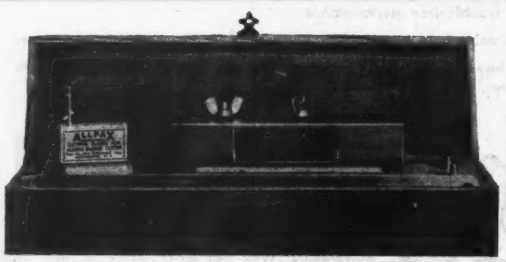


Old style steam piping required the purchase of 7 or more fittings . . . With this multiplicity of fittings is the cost of connecting them up. Not only are you required to purchase and install them but also each time a trap is inspected it has to be taken from the line and the installation cost is duplicated . . . Now, multiply these costs by the number of traps piped in the old style.

Compare these costs with that of Super-Silvertop Steam Traps requiring only one fitting that can be inspected without removal from the line. For true steam trap economy, use Super-Silvertops. Write for the book, "How to Choose a Steam Trap," giving complete details.

THE V. D. ANDERSON CO.
1939 W. 96th St. • Cleveland 2, Ohio

Super-Silvertop
STEAM TRAPS



Cuts your gasket costs in half

The most remarkable tool ever invented.

Write for Booklet

THE ALLPAX GASKET CUTTER

Manufactured by
THE ALLPAX COMPANY, INC.
Distributors everywhere — *Mamaroneck, N. Y.*

by The Rust Engineering Co., Pittsburgh, Pa.

The work, estimated to cost in excess of $2,000,000, includes erection of brick and steel pulp washing building with machinery and equipment, boiler house incorporating a 200,000 lb per hour steam boiler, coal bunkers and handling system; complete water treating plant; river water intake and pump house; new 7500 kw turbo generator; and auxiliary equipment.

The new boiler will be the ninth, and largest, fuel fired power boiler at the works. Water treating equipment and boiler feed pumps are incorporated besides coal handling facilities in the boiler house. One existing boiler is being converted to burning bark.

The water treating plant will treat all water for both power and recovery boilers. A new substation and pump room have also been provided. The river water intake and pump house will be constructed to provide circulating water to a condenser for the new 7500 kw turbine which will be installed to replace an old unit.

Dr. Sanford A. Moss Honored

DR. SANFORD A. MOSS, consulting engineer with the General Electric Co.'s Lynn, Mass., River Works, and pioneer in aircraft superchargers and the famous turbosuperchargers which are largely responsible for the increased range, speed, and altitude of modern aircraft, has been awarded the Holley Medal for 1945 by the American Society of Mechanical Engineers.

The citation accompanying the award to Dr. Moss praised his "Many contributions over a long period of years to the development of centrifugal compressors, particularly as related to the highly successful application of turbo-superchargers to internal combustion engines in the field of aeronautics."

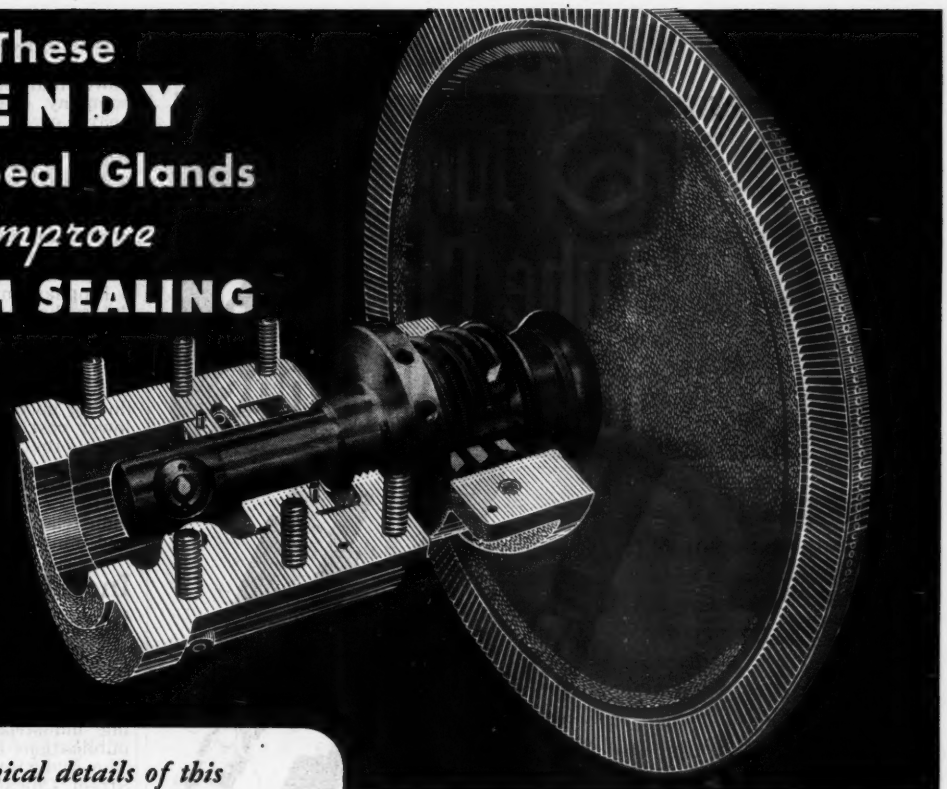
Since 1938 Dr. Moss has carried on his vital work in giving America's air power even greater power, and has earned many honors from engineering, military, and aeronautical groups for his great contributions to progress in the air. In 1942, on Dr. Moss' 70th birthday, General of the Army, then Lieut. Gen. H. H. Arnold, commander of the Army Air Forces, said in a telegram to Dr. Moss, "Personally and in behalf of the Army Air Forces, I send you sincere greetings upon your 70th birthday. Your contribution of the airplane supercharger and turbosupercharger is outstanding in the science of aeronautics."

Dr. Moss will be presented with the Holley Medal during the annual meeting of the American Society of Mechanical Engineers sometime in the latter part of November.

Power and Post-war Jobs

INDUSTRIAL POWER sales provide one of the keys to more jobs and a higher level of community prosperity after the war, it is declared in a survey of industrial power markets of the country by the Commercial Planning

These HENDY Dual-Seal Glands *Improve* STEAM SEALING



Technical details of this HENDY TURBINE FEATURE

Carbon seals at each end of the rotor shaft are held in contact with the grooved walls by coiled garter springs. The outer surface of each of the carbon rings is tapered in such a way that the spring, in retaining the ring, also forces it against one sidewall of the groove. The ring is thus positioned and supported; it cannot "ride" the shaft.

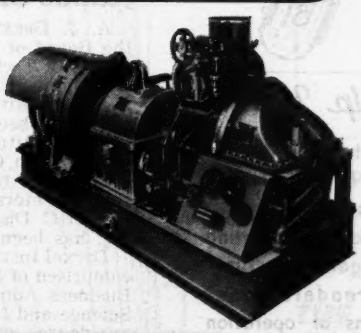
At the same time, the spring holds together the three segments of the carbon ring, maintaining a close clearance between shaft and ring. Sealing is thus accomplished at *both* the shaft and the sidewall, greatly increasing the sealing surface of each ring.

The housings for the carbon rings are split on the center line of the shaft, and may be removed without disturbing other parts of the turbine cylinder. This simplifies inspection or servicing of the glands.

Hendy turbine shafts are fitted with carbon gland rings that provide positive *side sealing* as well as *shaft sealing.* This construction reduces the number of rings required and prevents excessive leakage. In addition, this dual-sealing feature *minimizes shaft drag,* which can cause both shaft heating and excessive ring wear.

Refinement of design is characteristic of Hendy turbo-generators. Other advancements include a simplified governing system that results in accurate speed regulation . . . a new type of labyrinth seal between rotor disks that reduces interstage steam leakage . . . placement of oil filters, coolers, strainers, and other accessories that simplifies external piping. Details of these features are available upon your request.

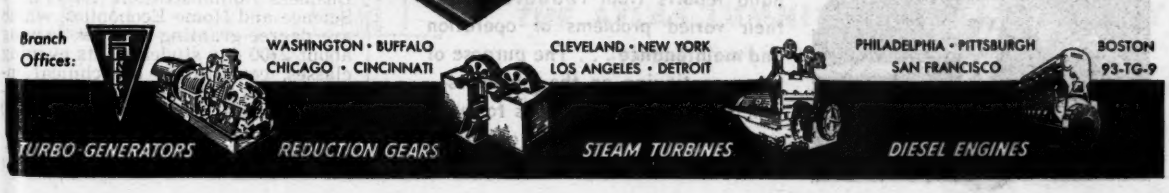
Hendy turbo-generators are available for marine and industrial applications—direct drive or reduction gear, depending upon requirements—in sizes from 250 kw up. You are invited to submit your power-plant problems to Hendy engineers—phone or write your nearest Hendy office.



Shown at right is the model HG-26 Hendy 300-kw turbo-generator. Large numbers of this type are being supplied for service on Navy and Maritime Commission vessels.

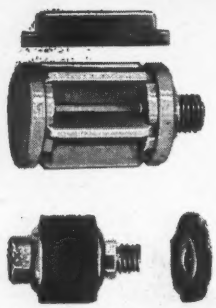
JOSHUA HENDY IRON WORKS
ESTABLISHED 1856
SUNNYVALE, CALIFORNIA

Branch Offices: WASHINGTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • NEW YORK • LOS ANGELES • DETROIT • PHILADELPHIA • PITTSBURGH • SAN FRANCISCO • BOSTON • 93-TG-9



Powerful-Fast

ROTO Junior Tube Cleaners for small tubes



For cleaning light scale from very small tubes, the fully self-contained Roto Junior Tube Cleaner offers advantages possessed by no other type. It is built with watch-like precision on the same time-tested principles as our large cleaners. The unusual power for its size is due to the positive contact between the solid blade and Rotocentric bore cylinder, which provides an undivided air stream and freedom from leakage. Roto heads and brushes have quickly-replaceable, inexpensive wearing parts which reduce greatly the cost of operation.

Simple Construction

A shaft and solid blade are the only moving parts in the Roto motor.

ROTO Division of Elliott Company

145 Sussex Ave. Newark 1, N. J.

How 273 Field Calls Help Us Help You . . .

DURING the last three years POWER PLANT ENGINEERING'S field staff has been ringing a lot of power plant doorbells, crawling under steam pipes, gathering first-hand reports from readers about their varied problems of operation and maintenance . . . The purpose of these continuing on-the-job chats—which total 273 to date—is to make sure that our magazine is geared to the practical needs of our readers.

Committee of the Edison Electric Institute, released recently. The survey, covering the major industrial power markets, is the work of power company executives representing nearly every section of the country.

"Full recognition," the report states, "is given to the need for a high level of industrial activity if we are to maintain employment, purchasing power, and avoid a lasting depression which will seriously affect the residential and commercial consumption of electricity."

Emphasizing that the electric industry has never recognized a limit to its growth, the report sees postwar gains ahead as the result of new inventions, new applications of electricity and improved methods of producing goods in greater quantity at lower cost even though competition from other sources of energy may be severe in certain fields of application. It takes up in detail the prospects for the use of power in such industries as steel, chemicals, foods and mining.

Industrial Information Service

A SERVICE DESIGNED to supply industry and business with quick references to sourecs of information on any business subject covered by leading industrial, trade and business publications has been announced by The Industex Co., 228 N. LaSalle Street, Chicago.

The service comprises summaries of publication articles printed on card index forms, indexed by subject matter and filed so that all information on a specific subject is quickly located in one place in the Industex file. Index forms carry 200-word digests of each publication article. This service, will make available publication information when needed, even though published months or years earlier. Industex is supplied on a subscription basis, and forms are issued monthly on current publications for addition to a subscriber's file.

Articles appearing in POWER PLANT ENGINEERING are covered in the Industex service.

Drexel Institute Elects James Creese President

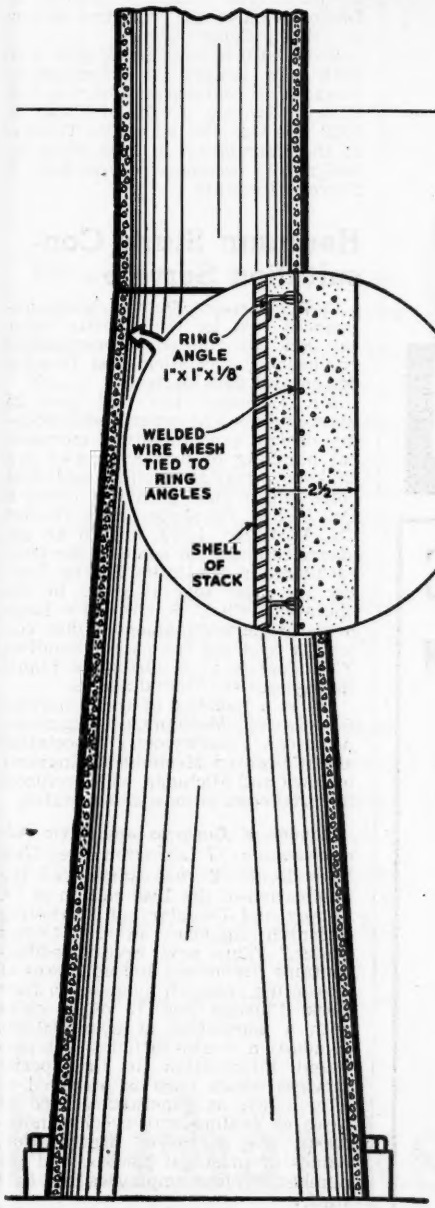
A. J. DREXEL PAUL, Chairman of the Board of Trustees of Drexel Institute of Technology, has announced that James Creese, vice president of Stevens Institute of Technology since 1928, has been elected president of Drexel Institute, and will assume his new post on Otcober 1.

Since the resignation of President George Peters Rea about a year ago, Robert C. Disque, Dean of Engineering, has been acting president.

Drexel Institute, founded in 1891, is comprised of Schools of Engineering, Business Administration, Library Science and Home Economics, which are degree-granting colleges serving about 2700 day students. Its evening classes, constituting a technical institute with a special faculty from industry, attract approximately 3000 students.

Before going to Stevens Institute Mr. Creese was associated for several

PROTECT STEEL and IMPROVE DRAFT with LUMNITE STACK LININGS



Corrosion-resistant linings insure long life for steel stacks. Insulation prevents oxidation, keeps gas temperature up and boosts the draft. LUMNITE linings are refractory, insulating and resistant to corrosion.

Stop oxidation, prevent the corrosive action of sulphurous flue gases, insulate the steel from high temperatures, and you have forestalled the enemies that destroy steel stacks. The jointless LUMNITE linings are in close contact with the steel. They allow no "breathing"; aggressive condensate cannot reach the shell of the stack.

A LUMNITE lining only 2½ inches to 3 inches thick gives full protection, while it allows maximum effective draft area. The efficiency of an old stack is increased; a new stack may be designed for greatest economy of steel.

In new stacks or old, it's easy to install these LUMNITE linings. Reinforcing mesh is attached to steel angles or other projections welded to the steel shell . . . the mixture of LUMNITE and insulating, corrosion-resistant aggregate is applied over the reinforcing mesh . . . then, 24 hours later, the lining is ready for service.

7 Ways to Use LUMNITE in Power Plants

1. Ash Pit and Cinder Catcher Linings.
2. Coal Bunker Linings.
3. Flue and Duct Linings
4. Steel Stack Linings.
5. Mortar for Brick Chimneys and Linings.
6. Castable Refractories.
7. Overnight Structural Concrete

For information on stack linings and other uses of LUMNITE in the power plant, write:

THE ATLAS LUMNITE CEMENT COMPANY

(United States Steel Corporation Subsidiary)

135 East 42nd Street, New York 17, New York

For Competitive Production . . .
you'll want power controls that help you achieve efficiency, give you consistent performance and keep maintenance low . . .
Power Control Check List
Feed Water Regulators
Pump Governors
Liquid Level Controls
Pressure Control Valves
Desuperheaters
Desuperheater Gov's
Differential Pressure
Master Regulators
Temperature Controls
Feed Water Heaters
Drainage Systems
Steam Separators
Air Separators
and Exhaust Heads
Check Swartwout
Install Dependable
Ask your consulting engineer or write us for help in planning for your new control equipment.
Swartwout
POWER PLANT EQUIPMENT
THE SWARTWOUT COMPANY • 18511 Euclid Ave. Cleveland 12, Ohio

VIKING ENGINE ALARM SYSTEMS

GUARD AGAINST ENGINE BREAKDOWN

from:

1. EXCESSIVE TEMPERATURE OF CIRCULATING-WATER SYSTEM
2. INSUFFICIENT PRESSURE IN LUBRICATING-OIL SYSTEM

WRITE FOR DATA SHEETS M-3 and M-3B

Every diesel and gas engine should be properly protected with a Viking alarm system. Viking is a *complete system*, no extras to buy. When water temperature becomes too high or oil-pressure too low, howler sounds to warn operator of danger. Type M-3B provides visual indication of source of trouble, also Heavy-duty construction, factory-set for your own requirements.

VIKING INSTRUMENTS, INC.
403 Fairfield Ave. Stamford, Conn.

years with the American Scandinavian Foundation. He is Chairman of the Executive Board of the American Association for Adult Education and has made a number of surveys of the extra-mural responsibilities of colleges and universities, and appraisals of educational projects in engineering.

Mr. Creese was born at Leetsdale, Pa., June 19, 1896, chiefly of Scotch-Irish ancestry. He attended the public schools and the Allegheny High School in Pittsburgh, and entered Princeton University in 1914 where he attained the degree of Bachelor of Letters in 1918 and Master of Arts in 1921. The honorary degree of Doctor of Laws was conferred on him in 1944 by Colby College.

From 1919 to 1928 Mr. Creese was with the American Scandinavian Foundation, and was knighted by the King of Sweden (Order of Vasa) in 1928. He was elected a Life Trustee of the Foundation in 1928 when he resigned to become vice president of Stevens Institute.

Hermann Starts Consultation Service

C. C. HERMANN, Detroit, Mich., announces that he will shortly enter the field of consulting mechanical engineering specializing on foundry design and dust control.

Mr. Hermann has had over 25 years engineering experience in foundry design, sand handling, mechanical handling of product, casting shakeout, casting cooling, and dust collecting in such plants as Deere & Co., Moline, Ill., John Deere Tractor Co., Waterloo, Iowa, and in an advisory capacity for some of the largest plants in the United States. During the past several years he cooperated with U. S. Ordnance Engineers in the development of dust collecting systems for safely handling TNT dust in U. S. Ordnance plants throughout the United States.

He is a member of the American Society of Mechanical Engineers, American Foundrymen's Association and a licensed Mechanical Engineer in Iowa and Michigan with reciprocity privileges in most other states.

School of Business and Civic Administration, 17 Lexington Ave., New York 10, N. Y., has announced the publication of the 1945 edition of "A Survey and Directory of Marketing Research Agencies in the United States." This new revised edition contains the names and addresses of marketing research agencies in New York, Chicago and 12 other cities with a population of over 500,000. In addition, it also includes such pertinent information as the special services which each is prepared to offer (such as general research or research dealing with specific industries), the date of organization, names of principal officers, and the number of office employees and field staff.

This book will be of definite value to manufacturers, advertising agencies, public utilities, libraries, and, in general, to anyone who is interested in marketing research and its possibilities. Its price is three dollars per copy.

Complete PUMPING UNITS

. . . built, guaranteed, and serviced by ONE manufacturer

Pump illustrated is single-stage, split-case centrifugal.

Fairbanks-Morse complete pumping units offer you much more than sustained high efficiency. There are in addition these three vitally important advantages:

1. ***Combined Responsibility.*** Designed and built in one factory, pump and driver (motor or engine) are perfectly matched and covered by a single guarantee.
2. ***Successful UNIT Performance.*** Tested in one plant under expert engineering supervision, pumps and drivers assure a superior result to the buyer.
3. ***Service from One Source.*** No questions about who is to make any required repairs or adjustments.

You can get these major advantages from Fairbanks-Morse . . . because Fairbanks-Morse designs and builds all components of an outstanding line of complete pumping units. To see a qualified engineer about any pumping job, write Fairbanks, Morse & Co., Fairbanks-Morse Bldg., Chicago 5, Ill.

BUY VICTORY BONDS

Fairbanks-Morse

A name worth remembering

Diesel Locomotives • Diesel Engines • Generators • Motors • Pumps • Scales
Magnetos • Stokers • Railroad Motor Cars and Standpipes • Farm Equipment

GRATE-Economy!

Increase Boiler Ratings at a Savings *with* MARION MASTER GRATES

• With efficient grates, coal waste is eliminated, boiler efficiency increased. MARION MASTER GRATES show immediate savings in fuel costs and send boiler ratings up. Clean fires assured with all grades of coal. Experienced workmanship and superior materials give strength and durability to MARION MASTER GRATES.

FEATURES

• Long Life of Bars Due to Depth of Center Rib—NO WARPED BARS!

• Permanent Pins—Steel Trunnion Pins Cast Into the Bars!

• Easy Operation—Smaller Bearing Surface of Pins Allows Easy Rocking.

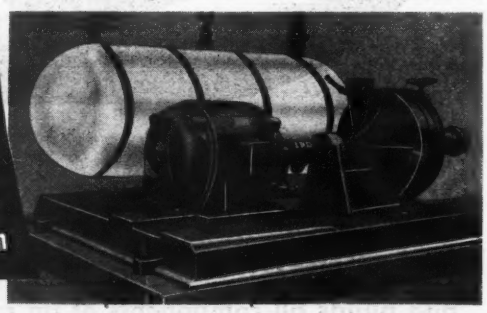
HERE IS TRUE GRATE ECONOMY! WRITE FOR BULLETIN G-45.

Grates to Suit All Conditions.

THE MARION LINE

MARION MACHINE, FOUNDRY & SUPPLY CO.
Marion, Indiana, U. S. A.

Increase YOUR PRODUCTION with the STOUT NO-VENT Boiler Return System



—for Cookers, Heaters, Driers, etc.

It operates continuously returning condensate, ALL OF IT, fast as formed and at the same pressure and temperature at which it leaves the steam heated units. Air and non-condensibles are then automatically removed and the condensate, in the form of distilled water, returned direct to boiler. There are no traps or orifices in the system.

High temperature direct return saves fuel. Often 25% or more. (This would offset the 20% cut expected in soft coal deliveries to industry as announced July 14th by Secretary Ickes.)

Improved circulation the Stout NO-VENT way uniformly increases the temperature in steam heated units and increases production. Reducing boiler load and returning distilled water prolongs boiler life.

If you operate steam heated cookers, heaters, driers, ironers, clothing presses, drying ovens, oil tanks, water tanks, pickling tanks or have other uses for so-called "process steam" investigate the Stout NO-VENT Boiler Return System. It can boost your production.

DAVID STOUT & SONS • 6 N. Michigan Ave. • CHICAGO 2, ILL.
Heat Reclaimers • Steam Condensers • Spiro Water Heaters • Gas Fired Boilers

Write for bulletin showing hookup of Stout NO-VENT System and giving operating details. Made in capacities 100 to 800 bhp, pressures to 200 lb. Distributors will be interested in selling franchise.

Stout NO-VENT BOILER RETURN SYSTEM

CLASSIFIED ADVERTISING

HELP WANTED

POWER ENGINEERS

Mechanical Engineers or Electrical Engineers, with aptitude and experience in heat balance thinking for work devoted to plant improvements, results engineering and effecting economy in the generation and consumption of steam, electricity, compressed air, water and refrigeration. Several openings for qualified men at different locations in the United States.

Give full experience, education, age, present salary and salary expected. Enclose snapshot.

Post-war opportunity.

Applicants must be able to obtain Statement of Availability.

E. I. du Pont de Nemours & Co., Inc.
Personnel Division
Wilmington 98, Delaware

DRAFTSMEN

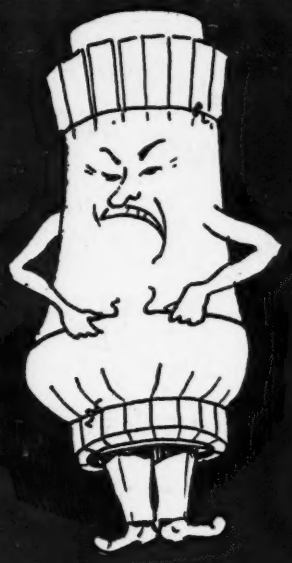
ELECTRICAL AND MECHANICAL. Electrical needed with diagram experience; Mechanical needed with detail and layout experience on machinery. Work in Pittsburgh area. Write Westinghouse Electric Corporation, Industrial Relations, 4N17. Give full details of experience, education, age, present salary, and salary expected.

DESIGNERS, draftsmen, piping and equipment post-war steam-electric plants. Chicago location. Laramore and Douglass, Inc., 327 S. LaSalle St., Chicago 4, Ill.

WANTED: Electrical Engineering graduate for permanent position as Chief Electrician's asistant in large public utility generating station located in the East. Address Box 1489, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

SALES-MINDED ENGINEER who can qualify by reciprocity or test, or who is registered in State of Oregon, to act as Sales Technician for firm selling Sewage Pumps and Pumps for Pulp and Paper Mills. Old etablished company distributing fine line of equipment. Opportunity to develop this division of the Pump Department and later head as sales manager. Knowledge of Pulp and Paper Industry desirable but not essential. Give age, education, experience, engineering record. Enclose picture. R. M. WADE & CO., 106 S.E. Hawthorne Blvd., Portland 14, Oregon.

TROUBLED BY "MIDDLE-AGE SPREAD"?

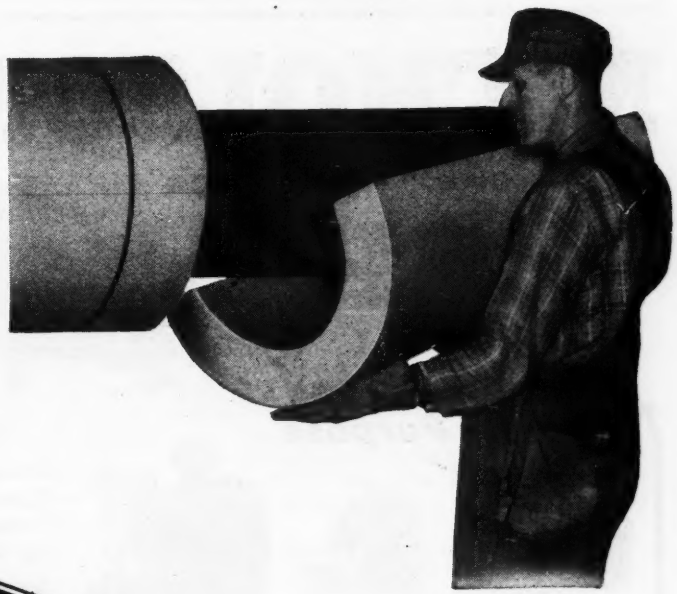


SIMPLY APPLY UNIBESTOS

it's simple to apply!

Unibestos, the sectional insulation, will not dent, shatter, sag or gap as the result of vibration, exposure to moisture or hard knocks. This greater structural strength is a result of Unibestos' resilient, tough fibrous construction.

Unibestos is available in half-section form up to 30" pipe diameter and in quarter sections from 32" to 60", in thicknesses from ¾" to 5". Single layer construction is available for service up to 1200°.



UNION ASBESTOS

MEANS PROGRESS IN INSULATION

AND RUBBER CO.

PLANTS: 1821 S. 54th Ave., CICERO, ILL. • PATERSON, N. J. • BLUE ISLAND, ILL.

OFFICES: CHICAGO • CICERO, ILL. • NEW YORK • SAN FRANCISCO • PATERSON, N. J.

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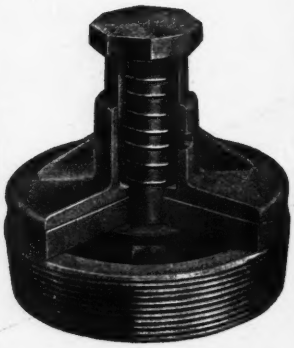
ION ASBESTOS AND RUBBER CO.

Can you afford to run racing STEAM-WASTING PUMPS?



S-l-o-w 'Em Down With COMBINATION NON-TILT VALVES

If your plant operates two or more reciprocating pumps — Boiler Feed, Vacuum, Condenser, General Service—the chances are that you can save up to 15% in steam and cut maintenance cost at the same time by using COMBINATION Pump Valves. They lift straight, close quickly, prevent racing and hammering, eliminate many pump repair bills. Ask for descriptive bulletin.

They Match the Fine Performance of Combination Silent Check Valves.

COMBINATION PUMP VALVE CO.
846 WIOTA STREET, PHILADELPHIA, PA.

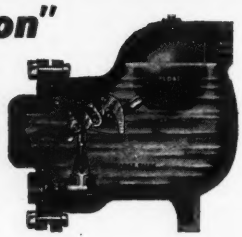
NICHOLSON

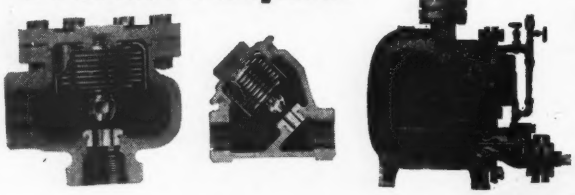
Makes "Fast Action"

TRAPS

FOR

Every Power and Process Purpose





★

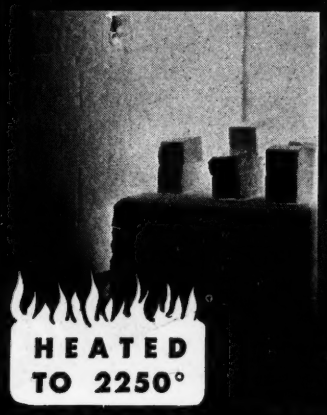
Write for Catalog 444 or See Sweet's

★

Featuring exclusive designs, Nicholson performance-proved traps assure enormous discharging capacity and faster, positive action. For all pressures. Descriptive of the complete Nicholson line, our Trap Catalog 444 is a standard reference on drainage problems, whose helpfulness will earn it a permanent place in your files.

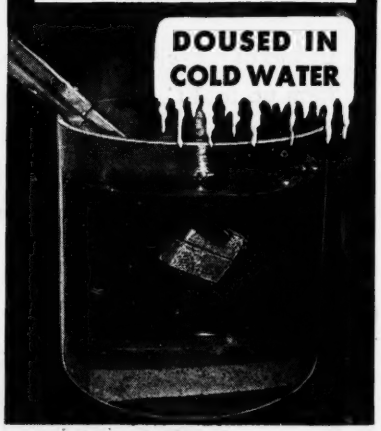
W. H. NICHOLSON & CO. 160 OREGON ST. WILKES-BARRE, PA.

Demonstrating
BRICKSEAL
REFRACTORY COATING



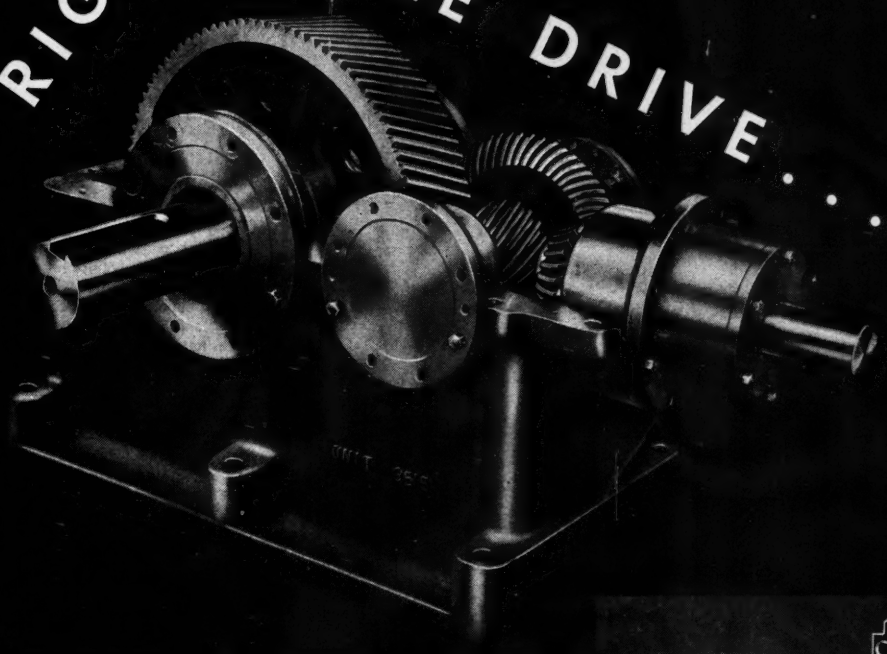
Brickseal provides a crackproof, vitrified armor for furnace linings. The small firebricks shown in the furnace were bonded and painted with Brickseal and heated to 2250°. Directly from the furnace they were plunged into cold water as shown below—a test for *any* material subject to expansion and contraction.

Brickseal is *semi-plastic when hot,* yet *hard and tough when cold.* Brickseal is made in grades suitable to heats ranging from 1400° to more than 3000°. It will make any furnace last longer by giving new life to your refractories. Write or call local dealer for a demonstration.



BRICKSEAL
REFRACTORY COMPANY
5800 S. Hoover St., Los Angeles, Cal.
1029 Clinton St., Hoboken, N. J.

a HIGH EFFICIENCY RIGHT ANGLE DRIVE . . .

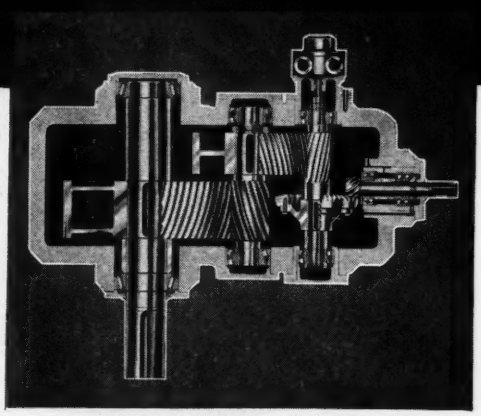


Spiral-Bevel Speed Reducers

These units provide a dependable means of transmitting power at right angles, either horizontally or vertically. They're made in single, double and triple reductions with standard ratios ranging from 1.5 to 1 up to 238 to 1. The single reduction units employ only spiral bevel gears, while in the double and triple reduction types helical gears are used for the second and third reductions.

An outstanding advantage of Philadelphia Spiral Bevel Reducers is the high efficiency rating, for example, the single reduction unit is approximately 98% efficient. That means all but 2% of the input power is transmitted to the low speed shafts . . . thus often smaller frame size motors can be used with spiral bevel units than with other comparable types of reducers.

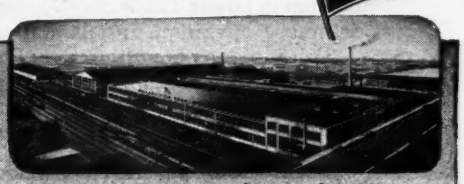
Our Bulletin 200 gives further details . . . a copy will be gladly sent in reply to a request on your business letterhead.



In the blue panel above is shown a Size 3515 Type BLT Double Reduction Spiral Bevel Helical unit. The lower illustration is a sectional view of a Triple Horizontal Unit, Size 3600 Type BLT.

Philadelphia Spiral Bevel units are performing satisfactorily in many types of service.

ARMY E NAVY



Philadelphia

GEAR WORKS INCORPORATED

ERIE AVE. AND G ST., PHILADELPHIA 34, PA. NEW YORK • PITTSBURGH • CHICAGO

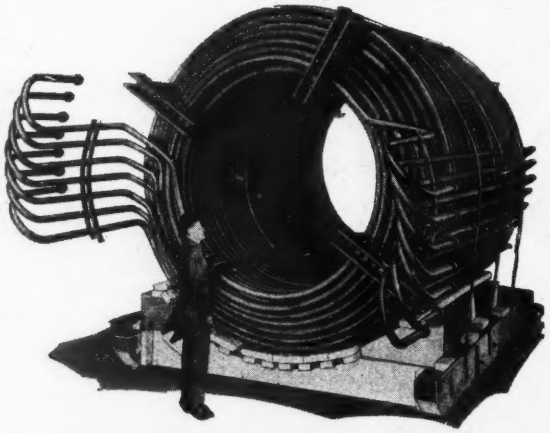
Industrial Gears and Speed Reducers
LimiTorque Valve Controls

9240 FT. SEAMLESS STEEL TUBING IN THIS REMPE COIL

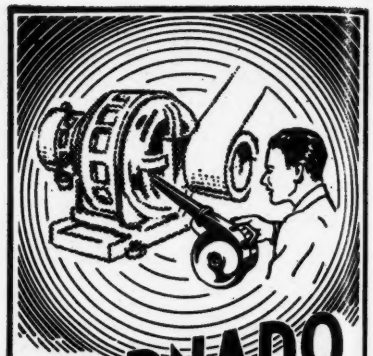
This giant Rempe heating coil consists of seven different circuits—more than 11 tons of Grade A-106 seamless steel tubing.

Rempe engineering service starts with the design and selection of materials best suited to the particular job and follows through all manufacturing operations to final thorough testing.

Send for estimates. For best results on your coil and bend jobs call on us for engineering assistance.



REMPE COMPANY
344 No. Sacramento Blvd., Chicago 12, Ill.



TORNADO
PORTABLE ELECTRIC BLOWER
reduces
DUST DANGER

BLOWS clean, dry air, at 295 m. p. h. Cleans out motors, generators and hard-to-get-at-places — removing dust, dirt, lint and chips. Costs less than 3c. an hour to operate. Reduces damage to motors and bearings — lessens fire and health hazards.

1 H. P. Universal G. E. motor. Weight, 14 lbs. Portable to any place in plant. Plugs in at convenient outlets. Adaptable as Sprayer for spraying paint and insecticide. Convertible into powerful industrial Vacuum Cleaner—for cleaning floors, walls, ceilings, etc.

Free Trial—Write to
BREUER ELECTRIC MFG. CO.
5108 N. Ravenswood Ave., Chicago

TAKE THE DUST OUT OF DUSTY
TORNADO

need help on Ash Removal?

• Get the help you need by installing the fully pneumatic Beaumont "Vac-Veyor" ash handling system. Conveys ashes, clinkers, soot from pits, chambers and stack to storage silo with minimum of power and labor. No dust. No "wetting" of materials. Continuous operation. Installation as simple as running a pipe line. Low first cost. Low operating cost. Minimum critical materials required. For details—write:

BEAUMONT BIRCH COMPANY
1503 RACE STREET PHILADELPHIA 2, PA.
DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS

LaMOTTE
BOILER FEED WATER TEST UNITS

The LaMotte Research Department has developed a reliable series of chemical tests for boiler feed water control of the following constituents:

Phosphates	**Dissolved Oxygen**
Chlorides	**Sulfates**
Total Alkalinity	**Hardness**
pH (Hydrogen-ion Concentration)	

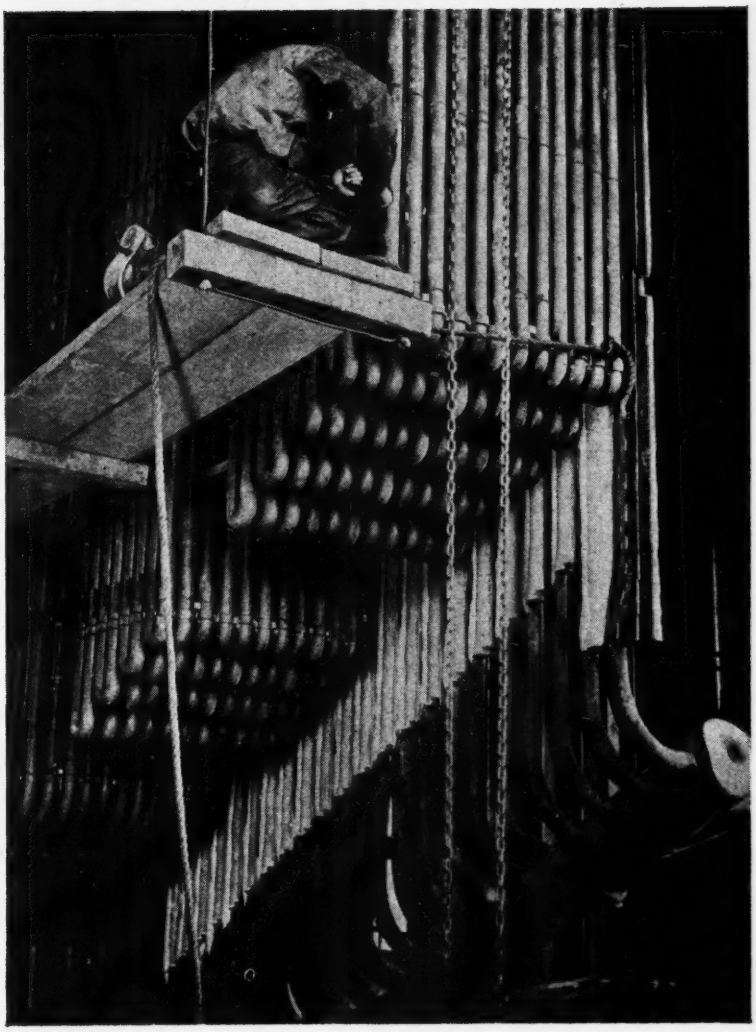
For positive control of efficient water treatment, there is a LaMotte Unit for each constituent (Phosphate Comparator, illustrated and described below). Each unit is simple to operate and inexpensive to install. Write for illustrated booklet describing this equipment.

LaMotte Phosphate Comparator

For control of phosphate treatment of boiler feed water. A rapid, simple and accurate method. The new LaMotte Comparator covers phosphate concentrations from 0 to 100 p.p.m. Can also be used for poly phosphates. Outfit comes complete with instructions.
Price $15.00 f.o.b. Towson.

LaMOTTE CHEMICAL PRODUCTS CO.
Dept. P.P.E., Towson 4, Baltimore, Md.

TUBES that are worth MILLIONS



A stake in every foot of B&W boiler tubing is the 64-year reputation for dependable performance earned by millions of dollars worth of B&W industrial, central station and marine boilers.

No one could be more directly concerned with a boiler's *performance* than the boiler *maker*—and a boiler is no better than its tubes. No one, therefore, has a stronger incentive than B&W to produce the best possible boiler tubes . . . because *no* other tube manufacturer is an integral part of an organization that also builds boilers. Every time you buy B&W tubes for *any* steam generating or heat transfer equipment, you get the same high quality, safety, dimensional accuracy and easy workability insisted upon in B&W tubes for all new B&W-built boilers. Besides, you get tubes matched to your specific service conditions without prejudice toward any type or materials because B&W makes BOTH SEAMLESS and WELDED TUBES—all to *one* high standard—for every power plant requirement.

B&W TUBES

SEAMLESS Complete range of carbon alloys and stainless steels
Sizes ½ in. to 8½ in. O.D.
ELECTRIC-Resistance Welded Carbon grades
Sizes ½ in. to 4 in. O.D.

THE BABCOCK & WILCOX TUBE COMPANY

Seamless Tube Division
BEAVER FALLS, PA.

Welded Tube Division
ALLIANCE, OHIO

TA1335

B&W MAKES BOTH

Right Joe—*

HERE IS YOUR ANSWER!

To eliminate scaling of heater tubes and the excessive use of exhaust steam for heating water, go to the source of the trouble—YOUR RAW WATER, with a complete water treatment service such as Nalco offers.

YES, JOE, to eliminate scaling of heater tubes and obtain more efficient heater operation and lower maintenance costs, your best bet is to properly condition the impurities in your raw water. You can do this with Nalco water treatment.

Nalco provides industry with a wide range of water treating chemicals and a complete follow-through program that helps banish boiler headaches. Your company, burdened by improperly treated boiler feed water, can improve plant efficiency and lower operating costs with Nalco water treatment.

Get a Nalco survey today.

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place, Chicago 38, Ill.

Canadian inquiries should be addressed to Aluminate Chemicals, Ltd., 555 Eastern Ave., Toronto, Ont.

* Joe—an operating engineer in a packing house says—*"Impurities in our city water and consequent scaling of heater tubes are causing us to use much exhaust steam for heating our water."*
SOURCE—Survey conducted by well-known power publication.

Photo in Nalco Laboratories

Harvey Berg
Nalco Representative
Dayton, Ohio

Nalco

THE SYSTEM OF SCIENTIFIC WATER TREATMENT FOR ALL INDUSTRY

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILER PLANT

1 **Spreader Stoker**—Detroit Stoker Co., 32-pg. Catalog No. 840 discusses the RotoStoker, in power dumping, hand dumping and stationary grate styles, for power field application under 100,000 lb. of steam per hr.

2 **Multi-Fuel Burner**—Variations in fuel availability are easily met with the B & W multi-fuel circular burner for pulverizer coal, oil and gas. Bulletin G-20A describes the burner in detail, shows how any of these fuels may be used singly or in any desired combination. Babcock & Wilcox Co.

3 **Coal Reference Bulletin**—Information on how low fusion Fairmont coal can be burned economically in any equipment designed for its use and why it will be available for many years to come is given in Coal Reference Bulletin recently issued by Fairmont Coal Bureau.

4 **Compact Steel Heating Boilers**—Technical data on modern steel heating compact boilers is presented in a new bulletin just issued by Titusville Iron Works Co. Containing informative diagrams and a wealth of engineering data for both the hand and mechanical fired boilers, the bulletin presents a complete story on the latest developments in compact, low pressure boilers.

5 **Coal Crusher and Sampler**—Illustrated booklet tells about Sturtevant automatic coal crusher and sampler. Enables you to sample one ton in one hour; accurate and easily adjusted. Sturtevant Mill Co.

6 **Coal Slicer Hoist**—Bulletin describes a two-drum electro-hydraulic, friction-clutch worm-geared hoist for operating a coal slicer. It permits fast, clean unloading of coal cars; eliminates need for men to operate crowbars or torches. Silent Hoist & Crane Co.

ELECTRICAL

7 **Switchgear for Low Voltage Circuits**—Detailed information on metal-enclosed dead front switchgear for low voltage distribution circuits is contained in a well illustrated, fully descriptive, 4-pg. bulletin issued by the Allis-Chalmers Mfg. Co. Pantograph drawout construction of breaker elements is featured. Permitting easy inspection, removal, and replacement of each air circuit breaker without disconnecting any other circuit, this construction supports each breaker on a framework which in turn is mounted on a simple pantograph.

8 **Cartoon Booklet on Electronics**—The Electronic Corporation of America has announced a 36-pg. booklet, The Amazing Electron, for distribution to engineers, consumer organizations, farm groups, and labor unions, and the general public. Illustrated in cartoon technique, and simply written, the booklet is intended to bring within the grasp of everyone the basic facts about electronics. Also describes many applications.

9 **Data on Distribution Transformers**—New booklet provides performance data, methods of calculating efficiency and impedance for oil immersed transformers. A valuable reference handbook for electrical men. Westinghouse Electric Corp.

10 **Locking Device for Fluorescent Lamps**—Flur-O-Locks, an inexpensive locking device for fluorescent lamps to eliminate the danger to employees and machinery from falling lamps, are described in new bulletin. Come in types to accommodate all standard lamp sockets, 20-watt to 100-watt lamps. Laduby Co.

11 **Data Book on Commutators and Slip Rings**—Engineers, electric motor maintenance men will find helpful data in the new catalog being distributed by The Toledo Standard Commutator Co. From 15 basic types—over 3000 variations of commutators and slip rings are listed in this book.

12 **Power Transformers**—Bulletin S-402 highlights modern trends in transformer design; gives ratings dimensions and other useful data on Standard transformers. The Standard Transformer Co.

13 **Motors and Transformers**—Wagner Electric Corp. issued a 16-pg. folder describing briefly its line of motors, transformers, industrial brakes and controls, hydraulic brakes, air brakes, tachographs (speed-recording speedometers).

14 **High-Speed A-C Generators**—Two new 4-pg. folders covering the A-C synchronous generators built by Electric Machinery Mfg. Co. are available. Publication No. 177 describes 3.75-4.38 kva generators, and publication No. 179 describes 250-5000 kva generators. The speed ranges from 500 to 1800 rpm. The frequency may be either 50 or 60 cycles. All standard voltages are available.

15 **Electronic Applications Primer**—To provide an understanding of the principles of electronics and an idea of the part electronics will play in future industrial developments, a 20-pg. book, entitled "Introduction to Electronics," has been produced by the Allis-Chalmers Mfg. Co. Differences between a vacuum tube and the equivalent mechanical device, methods of specifying tube performance, application of tube characteristics for design purposes, and use of the high speed response of the tube are explained.

FANS, PUMPS, COMPRESSORS

16 **High Pressure Fans and Blowers**—New Bulletin 745 gives a condensed description and typical performance curve of Buffalo Turbine axial flow high pressure fans and blowers. Advantages include reduced noise level, important space and weight savings. Buffalo Turbine Corp.

17 **Modern Pump Applications**—Attractive 32-pg. book, "Deming Pumps Everywhere," outlines progress of Deming organization since 1880; pictures applications of Deming pumps in factories, mines and quarries, hospitals, chemical plants, power plants, etc. The Deming Co.

18 **Refrigeration Compressors**—Accessibility, minimum gas friction and other features of Worthington horizontal double acting refrigeration compressors are covered in new 14-pg. bulletin. Typical installations of this steam engine driven compressor are shown along with data on floor space required. Worthington Pump and Machinery Corp.

19 **Propeller Pumps**—New bulletin on Fairbanks-Morse Niagara Propeller pumps has large sectional view to show propeller, top bowl and other features. Also provides capacity data and illustrates typical installations. Fairbanks, Morse & Co.

20 **Portable Air Compressors**—Worthington Blue Brute portable air compressor specifications and dimensions are given in new bulletin. Gasoline or Diesel engine drive, 105 cfm rating. Worthington Pump and Machinery Corp.

INSTRUMENTS AND CONTROLS

21 **Feed Water Regulators**—An 8-pg. Bulletin No. 83-C, entitled "Bailey Thermo-Hydraulic Feed Water Regulators," has been issued by Bailey Meter Co. It describes improved designs of thermo-hydraulic generators and bellows operated feed water regulator valves, suitable for feed lines ranging in size from ¾ in. to 6 in., inclusive. Full-page colored schematic illustration demonstrates the thermo-hydraulic principle which is entirely self-contained requiring no outside source of power. Bailey Meter Co.

22 **Instrument Control Boards**—New 6-pg. catalogue illustrates a large number of panel and cubicle installations constructed from Falstrom standard units. Also offers such useful information as: "How to Select Instrument Panels," "Falstrom Panels and Accessories," "Falstrom Standard Cubicles." Falstrom Co.

23 **Rotameter Nomograph for Steam**—A simple chart and table sheet makes it easy to select the correct rotameter size for steam measurement. Fisher & Porter Co.

24 **Industrial Thermometers Manual**—A 64-pg. comprehensive reference to their high-accuracy mercurial industrial thermometers and related instruments is available from Precision Thermometer and Instrument Co. Princo instruments described cover a wide range of industrial uses, including power plants, chemical and process industries, refrigeration, air conditioning, food processing, warehouses, paint and varnish manufacture, pipe lines.

25 **Ground Resistance Testing**—New bulletin on ground resistance testing deals with conditions generally encountered; describes the Vibroground, widely used for accurate, fast and dependable measurement, irrespective of earth resistance and conditions. It is a one-man instrument not requiring outside source of power, or mechanical operation. Associated Research, Inc.

26 **Instrument Manufacturing and Service Facilities**—This is the title of a 20-pg. booklet which outlines factory and repair facilities. Photographs show some of the custom-built instruments and special apparatus manufactured, as well as equipment and testing devices used in the laboratory for repair of electrical measuring instruments. Technical data regarding instrument principles and thermocouple use, and suggestions for instrument care are included. Nilsson Electrical Laboratory, Inc.

27 **Locke Regulators**—Catalog No. 50 describes Locke hydraulic regulators for controlling fuel and air supply to boiler furnaces; combination pressure regulators for controlling flow of steam, air, gas, water or oil; engine and turbine stop equipment, etc. Includes hookups, dimensional data and prices. Locke Regulator Co.

28 **Electric-Type Controllers**—The Bristol Co. has issued a new 16-pg. bulletin describing their new Microact and other electric-type pyromaster controllers. Different types are illustrated, contact and load circuit wiring diagrams are given, and typical applications are indicated.

MAINTENANCE MATERIALS

29 **Resurfacer for Worn Floors**—A folder issued by the Tufcrete Co. describes the uses of Tufcrete Resurfacer, indoors or out, on worn floors of wood, concrete, brick, asphalt, stone, etc., either for patching or a complete new surface. Tufcrete is described as an asphaltic-base liquid which, added to a concrete mixture, will bond to concrete, wood or other floors, both bottom and edges, will feather-edge perfectly.

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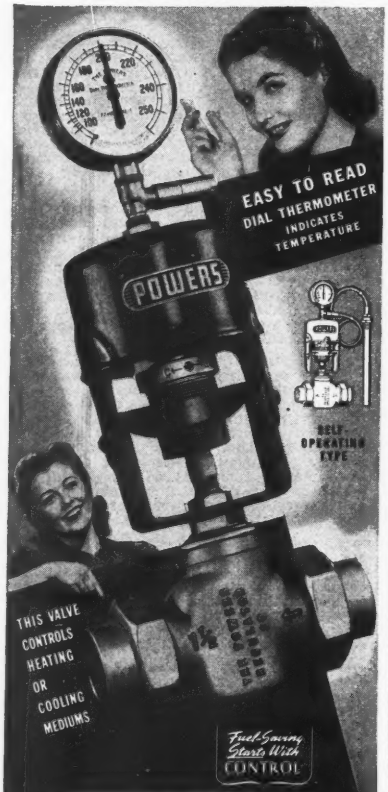

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30 **Forged Iron Ring Gaskets**—Technical Bulletin No. 45 describes Gruv-Seal forged iron and alloy ring gaskets and shows typical applications. Also provides information on standard sizes and dimensions for API and ASA ring numbers and additional sizes for other services. The Steel Improvement & Forge Co.

31 **Self-Bonding Flooring**—Maintenance men will be interested in new descriptive bulletin on Stonoleum. It is said that old pitted and cracked concrete floors do not have to be chipped away, nor does any bonding agent have to be used in laying this floor material. Continental Asbestos & Refining Co.

32 **Free Repair Handbook**—Company offers free 40-pg. guide for the use of Smooth-On cements, containing 170 diagrams and instructions for making lasting and economical repairs to plant equipment and machinery, pipe lines, fixtures, etc. Smooth-On Mfg. Co.

33 **Packing Selector Chart**—New 72-pg. Chesterton Catalog and handbook describes various types of Chesterton mechanical packings; contains packing selector chart, conversion tables for cutting ring packings and other useful engineering data. A. W. Chesterton Co.

34 **Quick Floor Repairs**—Flash-Stone, an immediate set resurfacer for quick repairs on industrial plant floors, is described in new folder. Material is said to adhere to concrete, wood, metal, brick or bituminous surfaces. Flash-Stone Co., Inc.

MECHANICAL TRANSMISSION

35 **Open End V-Belting**—A new catalog section on its line of open end V-belting has just been published by The B. F. Goodrich Co. Points out that open end V-belting helps insure efficiency and economy on many drives where use of endless V-belts is not practical. Line shaft and other similar drives can be utilized by using this type belting and fasteners. Rules for successful application of open end V-belting are given, including the method to determine pitch length, allowances for fastener length and for tension.

36 **Magnetic Pulley Catalog**—A new 32-pg. catalog describing electromagnetic pulleys and pulley type separators has been issued by the Dings Magnetic Separator Co. Describes uses of magnetic pulleys in paper mills, grain elevators, textile mills, foundries, flour mills, food plants, and many other industries; tells how to select a magnetic pulley; and includes tables, capacities, dimensions, etc.

37 **V-Belt Data Book**—How Veelos link construction provides quick, easy tension adjustment and other advantages in V-belt drives is illustrated in 8-pg. bulletin. Contains sample calculation for engineering a Veelos drive and other useful V-belt information. Manheim Mfg. & Belting Co.

PIPING, VALVES, FITTINGS

38 **New Valve Handbook**—The Powell "Quiz Kit" book is packed with useful handbook information on various types of valves—their selection, design, construction, application and care. Contains many piping practice diagrams of interest to engineers and plant maintenance men. The Wm. Powell Co.

39 **Steam Trap Handbook**—Tables, charts, diagrams and rules for selecting traps, giving complete explanations, make the new 36-pg. Armstrong Steam Trap Book a handy reference volume for every engineer's library. Armstrong Machine Works.

40 **Remote Control Valves**—Bulletin 800 describes the Grove Flexflo remote control valve for any fluid handling service such as oil, water, salt water, chemical solutions, gases and air. Just one more metallic moving part operates to open and close valve. Grove Regulator Co.

41 **Cast Steel Valves**—How OIC cast steel globe and angle valves provide greater dependability and flexibility with accurate flow control is discussed in new Bulletin No. 357. The Ohio Injector Co.

42 **Flexible Pipe Couplings**—Drinkwater, Inc., have issued a colorful 4-pg. engineering bulletin describing their new line of pipe couplings known as Presto-Lock flexible pipe couplings. Bulletin points to the many applications for Presto-Lock couplings, illustrates the simplicity of coupling parts and gives complete engineering data, drawings and specifications on the 11 sizes from 1¼ in. to 16 in.

(Continued on page 208)

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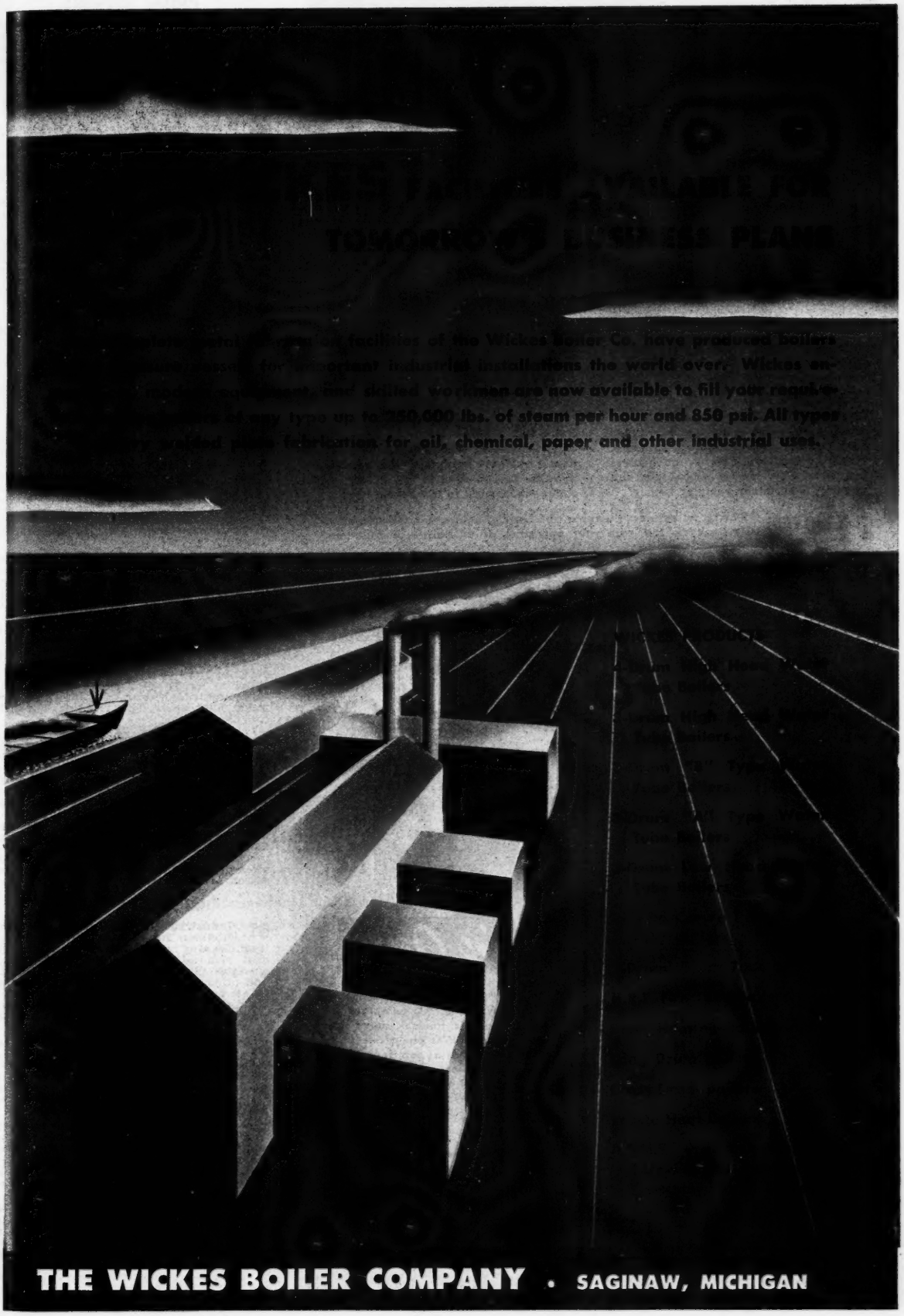
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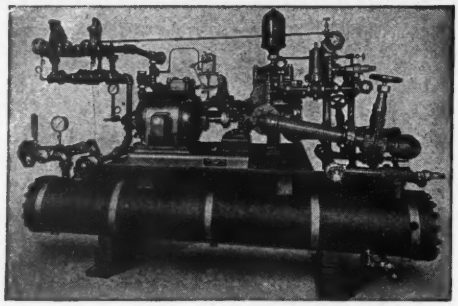

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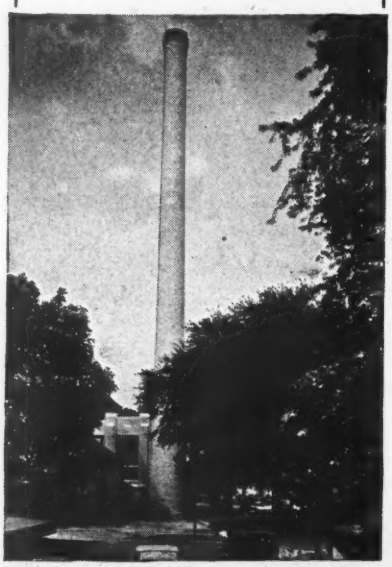

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PRIME MOVERS

43 **Turbine Generators**—Fully covered in Bulletin 1960 are design and operating features of Worthington turbines used for power and process or heating steam Describes advantages of straight non-condensing, non-condensing extraction and condensing extraction types; shows photos of typical turbine installations. Worthington Pump & Machinery Corp.

44 **Caterpillar Diesel Units**—New 32-pg. condensed catalog gives specifications and performance data on Caterpillar Diesel tractors; also portable industrial engines up to 190 hp and electric generating sets up to 90 kw. Caterpillar Tractor Co.

45 **Data on Internal Combustion Engines**—The Sterling Engine Co. has released a new catalogue that describes and briefs the specifications of engines now in production. Included are the Sterling Viking gasoline and gas engine, the Admiral gasoline engine in six and twelve cylinders, the Viking Diesel, marine and stationary, in six and eight cylinders, supercharged and unsupercharged. Contains many installation photos.

46 **Story of the Diesel**—"The Story of the Diesel," a 36 pg. booklet just published by the Diesel Engine Manufacturers Asan., discusses in concise, non-technical, easy to read style the Diesel's post-war future, its present fields of application, and advantages over other types of power.

WELDING

47 **Welding Technique Bulletin**—Ampco-Trode Welding Technique, a bulletin describing methods of welding with Ampco-Trode coated aluminum bronze weldrod, has just been released by Ampco Metal, Inc. This is a letterhead size edition containing a "Weldability Chart for Copper-base Alloys" that shows the range of metals that can be successfully welded with Ampco-Trode.

48 **Smooth Welded Pipe Joints**—Bulletin tells how the Westport patented welded joint allows complete penetration to the root of the weld, provides smooth contour at the base, prevents constriction in pipe flow. W. K. Mitchell & Co., Inc.

49 **Automatic Shielded Arc Welding Process**—New 26-pg. bulletin tells about Lincolnweld—a shielded arc welding process in which the weight of the flux consumed as slag covering is approximately equal to weight of electrode metal. Contains useful tables and tips on making butt welds, fillet welds, lap welds, etc. The Lincoln Electric Co.

50 **Welding Data Book**—A new 24-pg., two-color booklet, "Oxygen—Indispensable Servant of Industry," profusely illustrated and telling the interesting story about oxygen—how it is made and how it is used in industry—has been published by Air Reduction. Also treated is Airco's Applied Engineering Service for helpful technical and on-the-job assistance. Descriptions of hand and mechanical welding, flame hardening, flame cleaning, hand and machine gas cutting and other flame processes developed or perfected in Airco's Research Laboratories are included.

MISCELLANEOUS

51 **Industrial Vacuum Cleaners**—How the Hoffman heavy duty industrial vacuum cleaning system are being used to lick dust removal problems in power plants, chemical plants, textile mills, food plants and other plants is pictured and described in attractive 16-pg. bulletin. This modern cleaning method also brightens walls, gives workers better light, ends dust hazards. U. S. Hoffman Machinery Corp.

52 **Applications for Non-Magnetic Steel**—New 34-pg. bulletin tells about the properties of manganese steel; pictures applications for grinder and crusher parts, stator cores for motors and turbine generators, caps for scrap-bin walls and other jobs. American Manganese Steel Div.

53 **Induced Draft Cooling Towers**—New Bulletin No. 900 tells about design and performance of Binks Type 2K all steel induced draft cooling towers in capacities ranging from 40 to 600 gpm. Simple construction and easy installation are features of these towers. Binks Manufacturing Co.

54 **Corrosion Resistant Stoneware**—New Bulletin H covers specifications and applications of U. S. Stoneware, Tygon paint and other corrosion-resistant materials for piping, tanks, fan housings and impellers, agitators, hooks. Contains chart on corrosion resistant cement properties and other information useful to maintenance men. The U. S. Stoneware Co.

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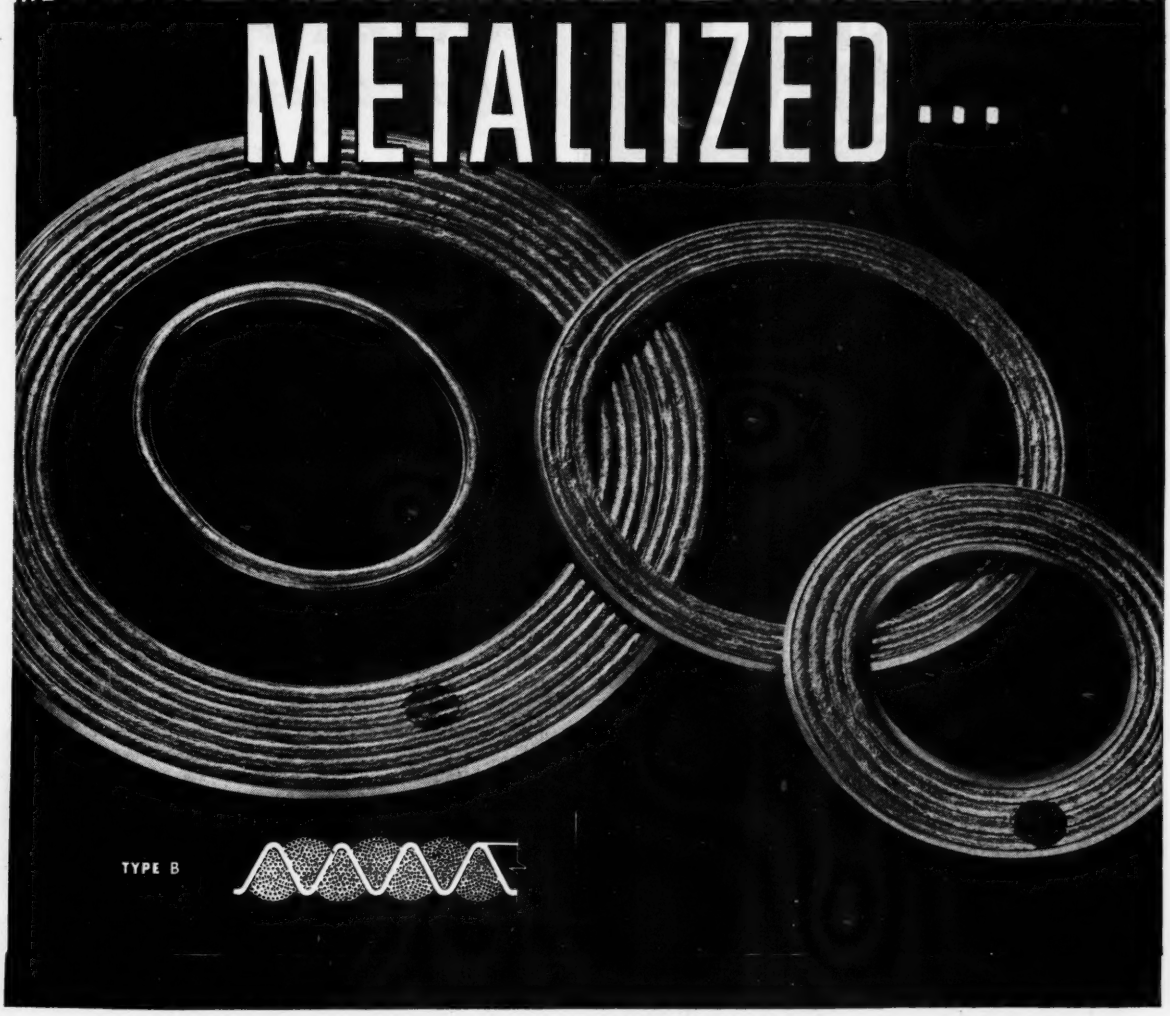

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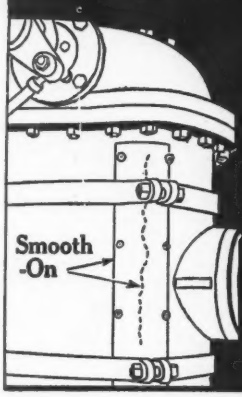

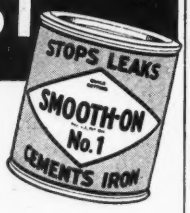

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POWER PLANT *Construction News*

Calif., Pasadena—Municipal Light and Power Department has plans under way for addition to municipal power plant, including installation of new 35,000-kw. turbine-generator, boiler and auxiliary equipment. Proposed to ask bids next Fall. Cost estimated about $2,520,000. C. W. Koiner, city manager, has recommended immediate construction to Board of City Directors.

Fla., Gainesville—Water, Light and Power Department will have plans prepared soon for extensions and improvements in municipal steam-electric power plant, including installation of additional equipment for increased capacity. Financing in amount of about $400,000 has been authorized for project.

Fla., Palatka—Hudson Pulp & Paper Co., 220 East 42nd St., New York, N. Y., plans new pulp and paper mill at Palatka, where large tract of land has been acquired. Project will comprise a number of one and multi-story buildings for pulp and paper-making divisions, equipped for large capacity. Electric power equipment will be installed. A power plant and pumping station are planned. Entire project is reported to cost over $3,500,000. Work is scheduled to begin soon.

Fla., Pensacola—Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensions and improvements in central power plant at Naval Air Station, Pensacola, with installation of equipment for increased capacity. Cost estimated at $959,000. Also will make extensions and modifications in steam distribution system to cost about $40,000, and in natural gas distribution system to cost approximately $25,000. Appropriations authorized.

Ga., Atlanta—General Motors Corp., General Motors Bldg., Detroit, Mich., plans new assembling plant near Atlanta, where tract of 250 acres of land has been acquired. It will comprise several large one-story buildings. Electric power equipment will be installed. A power house is planned. Entire project will comprise about 1,000,000 sq. ft. floor space and is reported to cost about $6,500,000. Proposed to begin work soon.

Ind., Wabash—Container Corp. of America, Inc., 111 West Washington St., Chicago, Ill., corrugated boxes and containers, plans extensions and modernization in power plant at box board mill at Wabash, reported to cost over $400,000, with equipment, latter to provide for considerable increased capacity. Sargent & Lundy, 140 South Dearborn St., Chicago, are consulting engineers.

Iowa, Cherokee—Town Council is considering new municipal power plant and has surveys and estimates of cost under way by Burns & McDonnell Engineering Co., 107 West Lindwood Blvd., Kansas City, Mo., consulting engineer. Proposed to hold special election on or about September 20 to approve project and necessary financing. Diesel engine-generator unit and auxiliary equipment will be used.

Iowa, Pocahontas—Central Electric Federated Cooperative Association, Pocahontas, has plans under way for new electric generating station to cost about $205,000, in which amount financing has been arranged through Federal aid. It is understood that Diesel engine-generator units will be used.

Ky., Louisville—Reynolds Metals Co., 2827 Hale St., aluminum and other light metals, plans installation of electric power equipment in new addition to local No. 8 plant, 2523 South Fourth St., estimated to cost about $200,000. Work will begin at early date.

Minn., Maple Lake—Rural Cooperative Power Association, Maple Lake, has plans in progress for expansion in local generating station, including installation of new oil engine-operated 1125-kva. generator unit and auxiliary equipment. Cost estimated about $200,000. Financing has been arranged through Federal aid. Pfeifer & Schultz, Wesley Temple Bldg., Minneapolis, Minn., are consulting engineers.

N. Y., Geneva—Geneva Forge Co., forgings and other metal products, plans installation of electric power equipment in new one-story addition, 400x600 ft., reported to cost close to $900,000, with machinery. Work will begin

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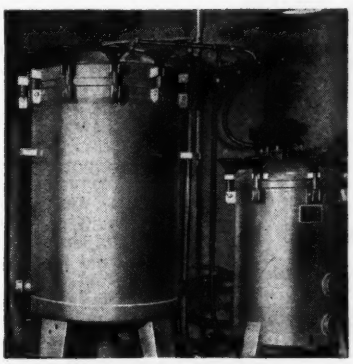

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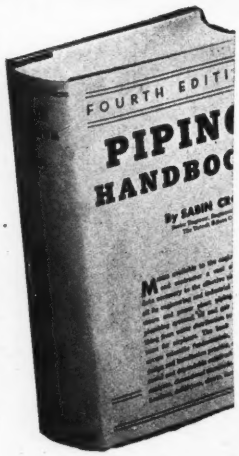

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soon. A. Epstein, 2001 West Pershing Rd., Chicago, Ill., is engineer. Company is affiliated with Ekco Products Co., 1949 North Cicero St., Chicago.

N. C., Roanoke Rapids—Halifax Paper Co., kraft papers, plans installation of electric power equipment in connection with expansion and modernization in pulp and paper mill for considerable increase in present capacity. Extensions will be made in power plant. Albemarle Paper Mfg. Co., Tredegar St., Richmond, Va., affiliated interest, will carry out similar program at local mills. Entire project will cost about $3,500,000. Financing has been arranged through RFC, and work will begin soon.

Ohio, Canton—Timken Roller Bearing Co., plans installation of electric power equipment in new one-story shop, about 90x200 ft., at Gambrinus, near Canton, for electric repair service, estimated to cost approximately $130,000, with machinery. Erection is scheduled to begin soon.

Okla., Altus—Electric Light Department has tentative plans for extensions in municipal power plant, including new Diesel engine-generating unit and auxiliary equipment. Estimates of cost will be made soon.

Pa., Willow Grove—Bureau of Yards and Docks, Navy Department, Washington, D. C., plans extensions in steam distribution system at Naval Air Sstation at Willow Grove. Cost estimated $95,000. Program scheduled to be carried out at early date.

S. C., Charleston—South Carolina Power Co., has plans maturing for new steam-electric generating station and contract for construction will be awarded soon. Project will include extensions in transmission lines, switching station and other facilities, and is reported to cost about $2,500,000. Engineering Dept., Commonwealth & Southern Corp., Alabama Power Bldg., Birmingham, Ala., is engineer, in charge.

S. C., Charleston—West Virginia Pulp & Paper Co., 230 Park Ave., New York, N. Y., plans expansion in power plant at pulp and paper mill at Charleston, with installation of a new 7500-kw. turbine-generator, boilers and auxiliary equipment. Work will be carried out in conjunction with additions and improvements in pulp and paper mill, including machinery installation for increased capacity. Electric power equipment will be installed. Entire program is reported to cost over $3,000,000.

Texas, Brownsville—Water and Light Department has engaged Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers, to make surveys and estimates of cost for proposed expansion in municipal steam-electric power plant, distribution system and waterworks facilities. Capacity will be increased.

Texas, Corpus Christi—Bureau of Yards and Docks, Navy Department, Washington, D. C., plans expansion on central power plant at Naval Air Station, Corpus Christi, with installation of equipment for increased capacity. Cost about $324,000. Appropriation has been authorized and work will be carried out soon.

Texas, Newton—Town Council has preliminary plans under way for new municipal power plant, using Diesel engine-generator unit and auxiliary equipment. Estimates of cost and surveys are being made by Garrett Engineering Co., 1806 Milam St., Houston, Texas, consulting engineer.

Wash., Seattle—Ford Motor Co., Northern Life Tower, Seattle, plans installation of electric power equipment in new parts plant on Fourth Ave., to be one-story, L-shaped, 232x427 ft. A boiler house will be built. Entire project is reported to cost about $775,000, with work scheduled to begin in Fall. Main offices are at Dearborn, Mich.

Wis., Marshfield—Water and Light Commission plans new boiler house at waterworks station, with installation of boiler with rating of about 60,000 lb. steam per hr., and auxiliary equipment. It is understood that construction will be carried out early in 1946. Helmick, Edeskuty & Lutz, Essex Bldg., Minneapolis, Minn., are consulting engineers.

Wis., River Falls—Electric Light and Water Department has preliminary plans in progress for addition to municipal hydroelectric generating station, with installation of equipment for increased capacity. Estimates of cost are being made. Mead, Ward & Hunt, 550 State St., Madison, Wis., are consulting engineers.

Wis., Wisconsin Rapids—Consolidated Water Power & Paper Co., has plans under way for new steam-electric power plant, about 75x100 ft., at local Biron paper mill, with installation of turbine-generator, high-pressure boiler and auxiliary equipment. Estimates of cost are being made. Proposed to begin work in Fall. W. F. Thiele is chief engineer, in charge.

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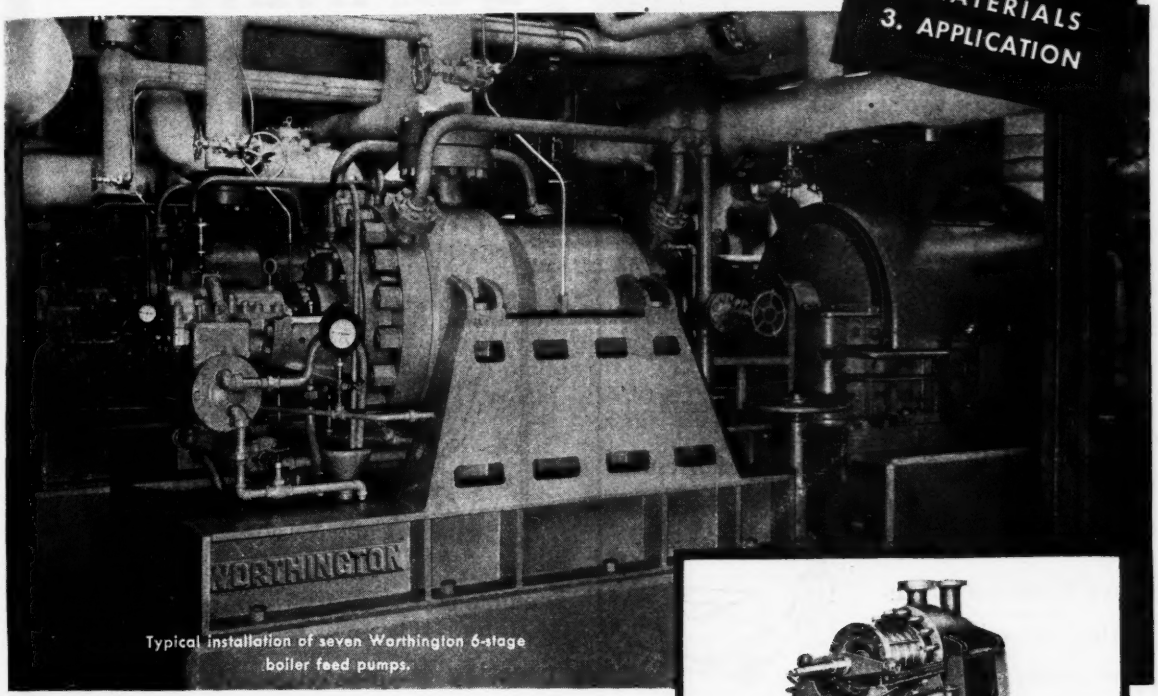
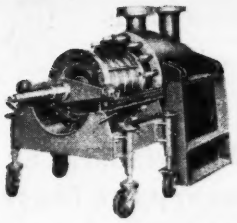
2. MATERIALS
3. APPLICATION



Typical installation of seven Worthington 6-stage boiler feed pumps.



AS EASY TO DISMANTLE AND ASSEMBLE AS A SPLIT-CASE PUMP

Complete rotor assembly of Worthington High-Pressure Boiler Feed Pump can be withdrawn *in one piece* on a portable assembly truck without disturbing suction or discharge piping connections. Simplifies inspection, replacement or repair of internal parts.

1. DESIGN—Worthington has longer experience in manufacturing high-pressure centrifugal boiler feed pumps . . . has acquired unique constructive ideas from power-plant operating engineers. That's why you'll find such superior design features in Worthington high pressure boiler feed pumps as: a balancing device construction that minimizes wear; bolted ring-type pressure joints; impellers shrunk on the shaft; oversized Kingsbury thrust bearings.

2. MATERIALS—Worthington has greater facilities for research. That's why you'll find the *right* materials in Worthington high-pressure boiler feed pumps: stainless steel for internal parts—to prevent destructive corrosion and erosion; forged steel casings—tested and proved by years of power plant operation.

3. APPLICATION—Worthington Pump Application Engineers are thoroughly versed in every phase of applying the most complete line of boiler feed pumps for high or low pressures — capacities from 50 to 3500 GPM . . . pressures from 50 to 2500 PSI. That's why Worthington will fit the *right* feed pumps to your feed cycle.

For further details on Worthington High-Pressure Boiler Feed Pumps . . . or for an appointment with a Worthington P.A.E.*, write us or telephone the nearest of our 36 district offices. You'll find that *there's more worth in Worthington. Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

*Pump Application Engineer

WORTHINGTON

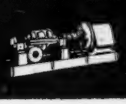
2405-3

THE WORLD'S LARGEST MANUFACTURER OF PUMPS

For Boiler Feed Service
Capacities from 30 to 1500 g. p. m. Heads from 180 to 1000 feet.

For Hotwell, Condensate, Chilled Water, General Service
Capacities from 150 to 1300 g. p. m. Heads from 110 to 500 feet.

For Boiler Feed Service
Capacities from 25 to 1450 g. p. m. Heads from 220 to 1600 feet.



For Water Works, Circulation, Drainage, General Service
Capacities from 500 to 1600 g. p. m. Heads 900 to 3200 feet.

For Boiler Feed Service
Capacities from 200 to 1600 g. p. m. Heads from 900 to 3200 feet.

For Boiler Feed Service
Capacities from 500 to 3000 g. p. m. Heads from 2000 to 7000 feet.

Do You Want to Save Your Floors?

THEN TRY THIS SIMPLE TEST

We will send a drum of STONHARD RESURFACER to any responsible company or institution, and you may repair ruts, holes or breaks; or resurface that portion of your floor which is under constant trucking and traffic.

Then test the results under your own working conditions for 30 days. If you are not satisfied, *we will cancel our invoice.*

STONHARD RESURFACER Will Prove Satisfactory for These Reasons:

1. Bonds to a feather-edge over concrete, wood, brick or composition surfaces.
2. *Stonhard Resurfacer* is tough, resilient and fire-resistant . . . Shock-proof too.
3. *Stonhard Resurfacer* provides a dampproof, non-dusting and non-skid surface.
4. The more trucking and traffic over *Stonhard Resurfacer,* the more serviceable it becomes.
5. No skilled labor is required to apply *Stonhard Resurfacer.*

Get a drum on our TRIAL BASIS, or send coupon below for more detailed information and FREE literature.

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Serving the Railroads, Public Utilities and Industries Since 1922
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STONHARD COMPANY
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Address.....
City.....Zone.....State.....

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Buy More WAR BONDS

The time is rapidly approaching when the whistles will blast out the good news that will permit an easing of restrictions which have affected shipments to civilian users.

We hope it will be soon when prompt shipments can be made of all the rod and sheet packings you want.

It looks brighter now for more of our production becoming available for civilian use. This includes Rod and Sheet Packings as well as Belting, Hose and all types of Industrial Rubber Products.

Quaker all during the war has steadfastly turned out Industrial Rubber Products. It is good policy to keep on asking for Quaker—the name that stands for Quality Industrial Rubber Products.

Reg. U. S. Pat. Off.

If there is a way to get it done QUAKER will do it

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Mfrs. Industrial Rubber Products
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Western Territory
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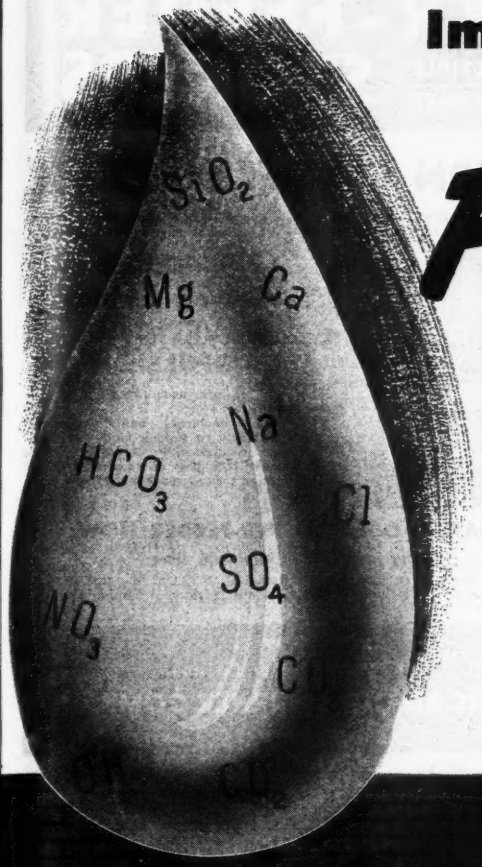
Untreated Water or Improperly-Treated Water is

Full of Trouble



The Dearborn Engineer works with the men in the boiler room—to ferret out the trouble-makers in bad-acting boiler water . . . those harmful chemicals that cause foaming, scale, corrosion, or pitting.

First, he checks over plant operating conditions, takes the necessary samples of the water, and makes "on the spot" analyses. Samples are also sent to the Dearborn laboratories for final analysis which, together with the plant survey, makes possible final recommendations.

Dearborn Engineer lives in your vicinity, and knows local water characteristics and can usually get to the bottom of trouble very quickly. A call will bring him to your plant.

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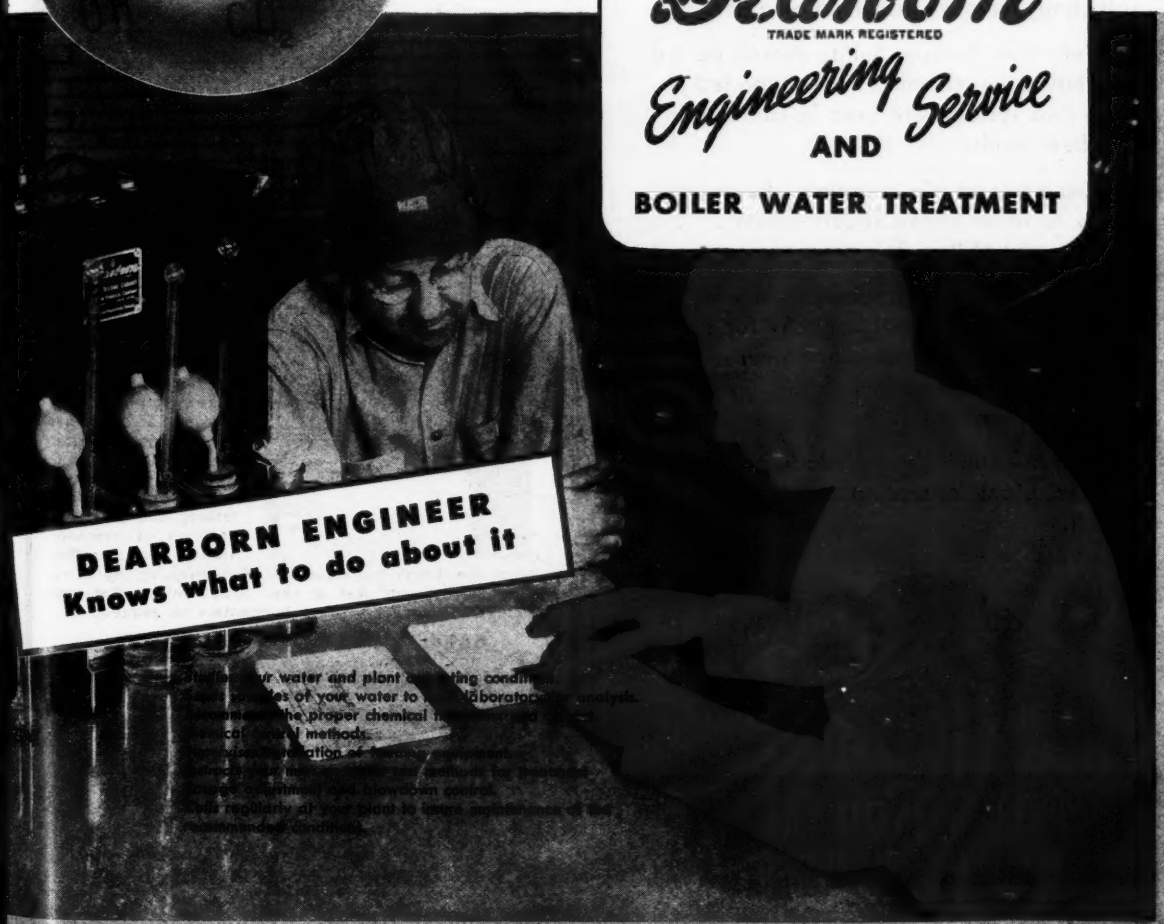
Dept. F, 310 S. Michigan Ave., Chicago 4, Ill.

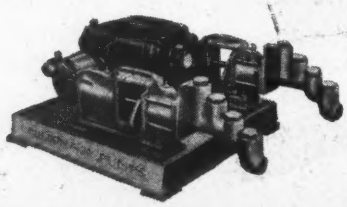
Dearborn
TRADE MARK REGISTERED
Engineering Service
AND
BOILER WATER TREATMENT



DEARBORN ENGINEER
Knows what to do about it

New . . . Bulletin on Boiler Water Chemical Treating Units . . . . . .

- Tells how to protect boilers against corrosion and pitting . . . prevent scale, control alkalinity, remove dissolved oxygen.
- Tells how Sodium Sulfite should be fed . . . how other chemicals should be fed . . . why two systems are used in combination for best results.
- Describes simple, complete "Packaged" units to meet above requirements . . . a brand new Milton Roy development.
- Contains selection tables from which to choose units of proper capacity for single or multiple boilers operating over a wide range of pressures and make up water requirements.
- This bulletin is "must" reading for every power plant operating engineer. Send for it.



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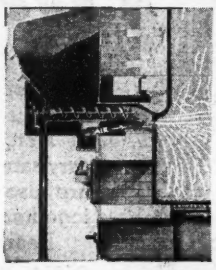
FYR-FEEDER MULTIPLE SPREADER STOKERS

BURN COAL LIKE OIL

Save with FYR-FEEDER—Burn less coal—Cheaper coal—Local coals—Screenings—Coal Yard Sweepings, wet or dry—WET coal is no handicap.



FYR-FEEDER exclusively employs air JET Coal PROPULSION

Fines burn in suspension, larger pieces are spread evenly over grate.
FYR-FEEDER increases boiler capacity—responds instantly to sudden load variations—requires no special skill or experience to operate—thin fuel bed eliminates clinkers—makes fireman's work much easier—no banking losses.

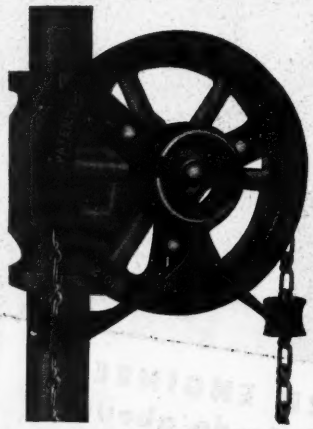
CHANGE OVER TO FYR-FEEDER NOW
Easily installed in minimum time

FYR-FEEDERS are built in sizes to burn from 300 to 12,000 lbs. coal per hour. If you are or expect to be in the market for automatic coal burning equipment

Wire or Write
FYR-FEEDER Stoker Division
AMERICAN COAL BURNER COMPANY
Engineers

22—19 E. Erie St. Chicago 11, Ill.

Think of the TIME You ll Save



with Babbitt Sprocket Rims on all your "high-up" valves. No need of keeping a long, cumbersome ladder always on hand just to close a valve.

Babbitt Rims give you instant and positive control of overhead valves from the floor —save time, steam and accidents. Adjustable to any valve, easily attached, and low in cost. Don't delay. Get your Babbitt Rims now! Complete information on request.

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South Water, Spring and First Sts.
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Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

CHOSEN FOR VICTORY AND LIBERTY SHIPS

PARACOIL Heat Transfer Equipment is proving its efficiency, rugged construction and economical maintenance on scores of Victory and Liberty Ships.

The U. S. Maritime Commission selected Paracoil Feed Water Heaters as standard equipment on all *Liberty Ships,* and Paracoil Self-Cleaning Fuel Oil Heaters as standard equipment for the pump and heater assemblies illustrated, on more than 500 *Victory Ships.*

Davis Engineering Corporation has built more than 1800 Paracoil Feed Water Heaters for the Liberty Ships and more than 1500 Paracoil Self-Cleaning Fuel Oil Heaters for the Victory Ships.

Paracoil Self-Cleaning Fuel Oil Heaters were preferred by the U. S. Maritime Commission because of the exclusive self-cleaning feature, high heat transfer rates, and small size. The heating surface of these heaters can be regularly cleaned while the heater is *in operation,* an important feature not possessed by any other heat exchanger. Disconnection of piping and disassembly of heater for cleaning is *not* necessary.

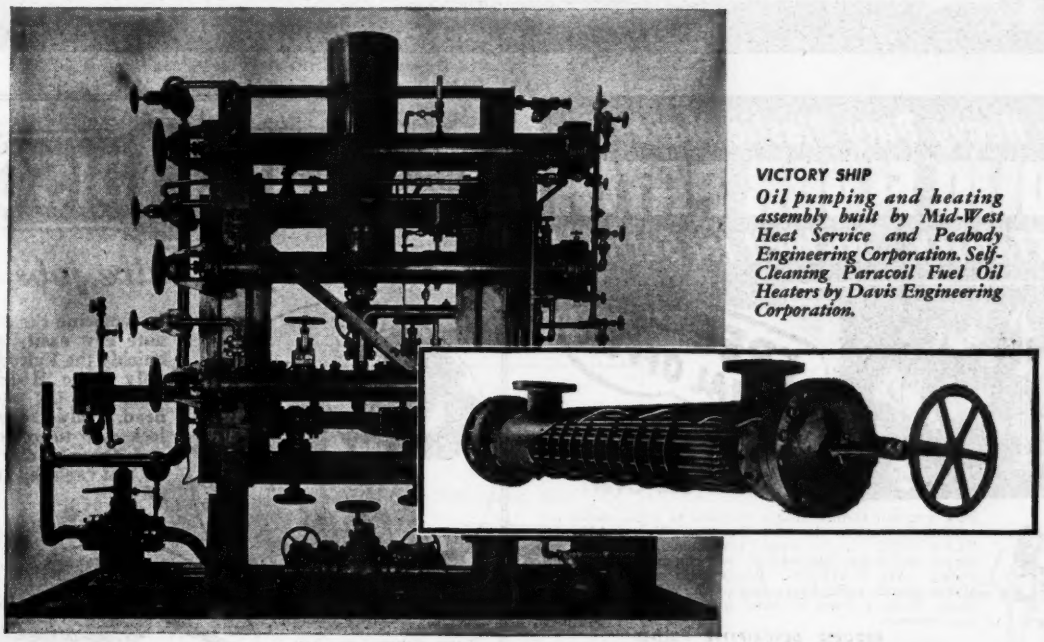
Cleaning is accomplished without the mess customarily attendant, at a saving of many man hours and without standby or duplicate equipment.

If used regularly and periodically as required by the quality of the oil and the conditions of operation, the Paracoil Self-Cleaning Device permits the elimination of fouling deposits which decrease heat transfer rates with resulting lowered oil temperatures, and in many cases, inefficient operation. In heat exchangers equipped with the Paracoil Self-Cleaning Device heat transfer rates can be maintained constant and uniform.

In both Marine and Stationary fields, Paracoil Heat Exchangers have been honored by their selection for jobs requiring the best, because of their reputation for advanced design and high quality of material and workmanship. To all industries using heat exchange equipment, the name "Paracoil" is a symbol of dependable, economical and trouble-free service.

Whatever your particular heat transfer requirement may be, our engineers are at your service to guide you in the selection of proper equipment for your conditions.

Write for Bulletin HE-100 describing the Paracoil Self-Cleaning Tubular Heat Exchanger.



VICTORY SHIP
Oil pumping and heating assembly built by Mid-West Heat Service and Peabody Engineering Corporation. Self-Cleaning Paracoil Fuel Oil Heaters by Davis Engineering Corporation.

SINCE 1915
Paracoil
HEAT TRANSFER EQUIPMENT

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Used OUTDOORS or INDOORS . . .

Connery Construction Holds Down Maintenance Costs

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QUARTERMASTERS DEPOT PHILADELPHIA, PA.

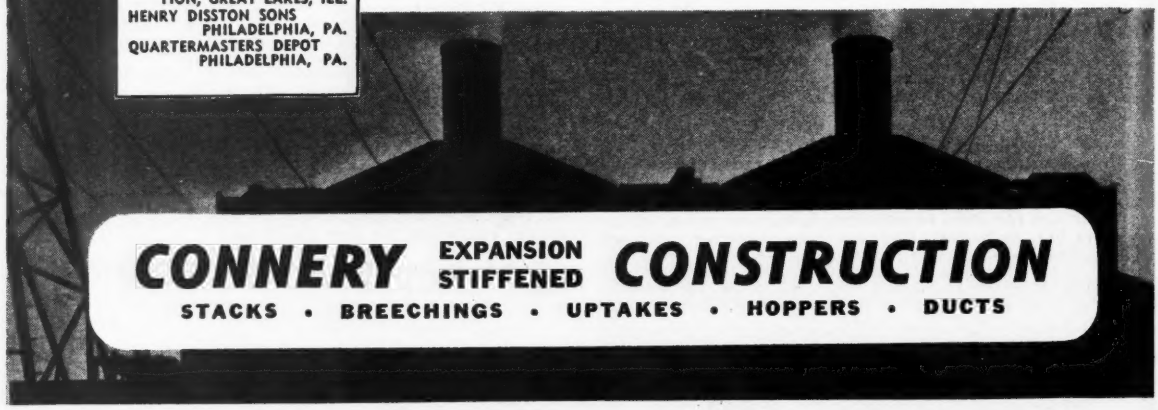
For breechings outside of the plant—for uptakes, air ducts, and other construction inside—Connery jobs simplify plant design and cut maintenance costs to the bone.

Much of the ability of Connery Construction to deliver long, air-tight, moisture-tight service comes from the use of Connery's "V" type stiffeners, cold pressed into the sheet metal from which the breechings or ducts are formed.

This improved Connery Expansion-Stiffened construction, plus electrically welded joints, eliminates buckling and warping—provides reinforcement that is uniform and many times stronger than any structural member of equal size.

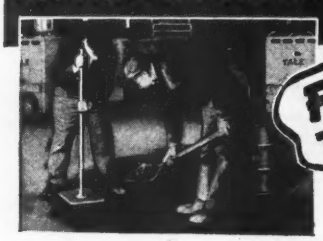
Connery Construction has always been a good buy—hundreds of installations prove it. Under present conditions, it is even a better buy. Ask for a Connery bid on that new plant expansion or modernization job.

CONNERY CONSTRUCTION CO.
Second & Luzerne Sts., Philadelphia Pa.



CONNERY EXPANSION STIFFENED CONSTRUCTION
STACKS • BREECHINGS • UPTAKES • HOPPERS • DUCTS

Heavy Duty Plastic Makes
SOLID FLOOR PATCH
INSTANTLY...No Wait for Setting!



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Now you can restore broken concrete to solid smoothness without having to close off the area. Use durable INSTANT-USE . . . a tough, plastic material which you simply shovel into hole—tamp—and run traffic over immediately. NO WAITING. Bonds tight to old concrete. Makes smooth, solid, heavy-duty patch. Withstands extreme loads. Keep a drum on hand for emergencies. Immediate shipment.

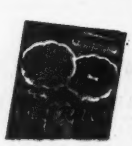
REQUEST DESCRIPTIVE FOLDER and Details of FREE TRIAL OFFER

INSTANT-USE

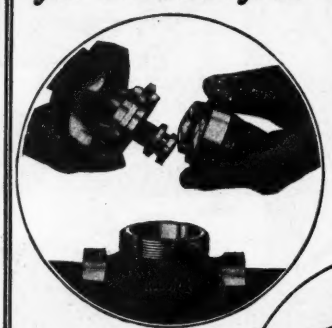
FLEXROCK COMPANY
3623 Filbert St., Philadelphia 4, Pa.

Please send me complete INSTANT-USE information and details of FREE TRIAL OFFER—no obligation.

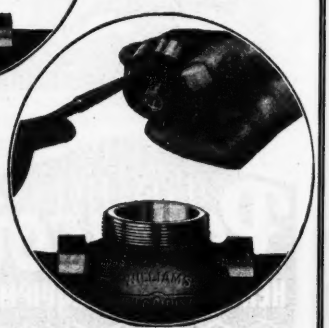
Name .....
Company .....
Address .....



Use VULCODISC
for trouble-free valve jobs



In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.



Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften—in fact, its absorption is less than 1 per cent. . . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder.

THE D. T. WILLIAMS VALVE CO.
Cincinnati, Ohio

Now UP TO 2000 hp!

STANDARD 2000-HP TRI/CLAD MOTORS NOW AVAILABLE

THEY GIVE EXTRA PROTECTION 3 ways

1 Extra protection from physical damage—Cast-iron construction. Upper portion completely enclosed. Streamline, cast-iron end shields. Corrosion-resisting finish.

2 Extra protection from electrical breakdown—Windings of Formex* wire, strongly bonded with oil- and moisture-resistant synthetic resins, stand up under abrasion or "heat-shock."

3 Extra protection from operating wear and tear—Sleeve or ball bearings, in dust-tight housings. Sleeve-bearing design is a further refinement of well-proved Tri-Clad bearing proportions, with cast-in "air seal" to further insure oil tightness of the housing.

The triple-protected construction that has made General Electric's Tri-Clad motor so popular in the small and intermediate sizes has now been extended to motors of 2000-hp capacity. On your *big* drives, these new Tri-Clad motors will meet severe conditions with greater assurance than ever of dependable service and long life.

The Tri-Clad motor, in its wide range of types and sizes, is industry's most popular integral-hp motor. Chances are there's a standard Tri-Clad to meet your requirements "on the nose." For information on G.E.'s complete line of Tri-Clad motors, ask for Bulletin GEA-3580. *General Electric Company, Schenectady 5, N. Y.*

Three of the new, large Tri-Clad motors, each rated 200 hp, 1200 rpm, driving coal pulverizers in a Southern steam-electric plant

*Trade-mark reg. U.S. Pat. Off.

HERE'S TODAY'S WIDER RANGE OF STANDARD SIZES	
TRI/CLAD Type K	—1 hp to 2000 hp at 1800 rpm
TRI/CLAD Type KG (High starting torque, low starting current)	—5 hp to 200 hp at 1800 rpm
TRI/CLAD Type KR (High starting torque, high slip)	—Available to 100 hp in speeds required for high-slip, flywheel drive (punch press, etc.)

Buy all the BONDS you can—*and keep all you buy*

GENERAL ELECTRIC

...to valve remote control problems

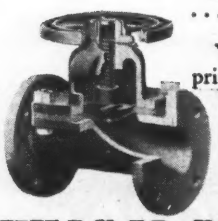
HILLS-McCANNA *Diaphragm* Valve (SAUNDERS PATENT) with Westinghouse Flexair and Controlair Controls.

NOW you can have all the advantages of a Hills-McCanna valve . . . plus operation by air. It's the answer to many valve remote control problems. Westinghouse Flex-air and/or Controlair Controls and an air actuated piston mounted on a Hills-McCanna Diaphragm Valve, make up this effective combination . . . provide a reliable means of valve control from a central point in your mill or factory.

If your need is for a simple open and close valve operation, a Hills-McCanna unit, equipped with a Flex-air Control, may solve your problem. And where a throttling type valve is required, Controlair Controls and a Hills-McCanna Diaphragm Valve and Piston operation, will help meet your want. Whether it's Flex-air or Controller-equipped you get smooth, air operation over a wide range.

Since all installations include an auxiliary air tank as part of the design, there's power to operate the valve even if the main air supply or all other power should fail.

And remember, Hills-McCanna Diaphragm Valves are absolutely leakproof, control the flow and keep unwanted material out of the line, won't clog or stick . . . have working parts isolated from the flow . . . and require no packing.



Write for the fact-packed blueprint that describes the operation and installations of this air activated valve. Available in sizes ranging from 4" to 12" inclusive.

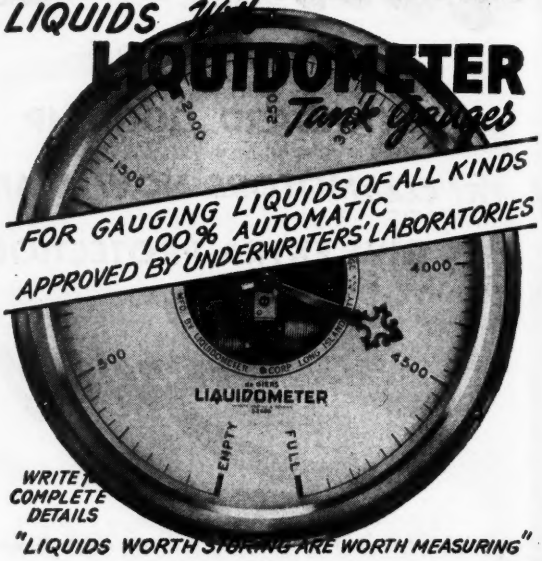
HILLS-McCANNA COMPANY

2439 W. Nelson St., Chicago 18, Ill.

Proportioning Pumps — Force Feed Lubricators — Chemical Valves — Air and Water Valves — Marine Valves — Magnesium Alloy Castings

COSTLY HUMAN ERRORS ELIMINATED WHEN YOU MEASURE VALUABLE STORED LIQUIDS With LIQUIDOMETER Tank Gauges

FOR GAUGING LIQUIDS OF ALL KINDS 100% AUTOMATIC
APPROVED BY UNDERWRITERS' LABORATORIES



WRITE FOR COMPLETE DETAILS

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THE LIQUIDOMETER CORP.
36-31 SKILLMAN AVE., LONG ISLAND CITY, L.N.Y.

MANZEL LUBRICATORS Give You PRECISION LUBRICATION

Because they pump exactly the required amount of oil with clock-like regularity, Manzel Lubricators are favorites for engines, pumps, compressors and heavy machine tools. For nearly 50 years they have been protecting cylinders and bearings.

Feed is easy to adjust and very accurate. Once set, the only attention the Lubricator requires is to keep oil reservoir supplied.

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WATERPROOF AND HIGH HEAT LINING

PLASTIK STEEL

for alkaline, sulphurous and leakage protection of tanks, stacks & breechings has been time tested by industry. One of the world's largest packing plants lined several hundred tanks with PLASTIKSTEEL during 1944 and are well pleased with result.

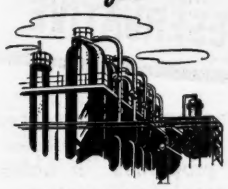
Picture at right showing 200,000 gallon R. R. tank being lined with PLASTIK-STEEL.

PLASTIC STEEL SERVICE

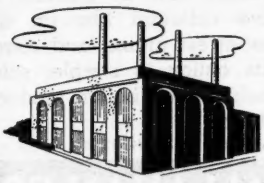
210 California Street — **San Francisco 11, Calif.**

ZURN

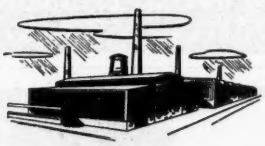
FLUID HANDLING EQUIPMENT *for*



PROCESS INDUSTRIES



POWER PLANTS



INDUSTRIAL PLANTS

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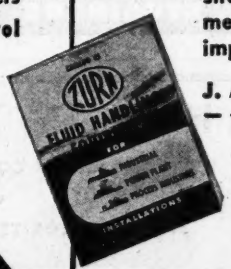
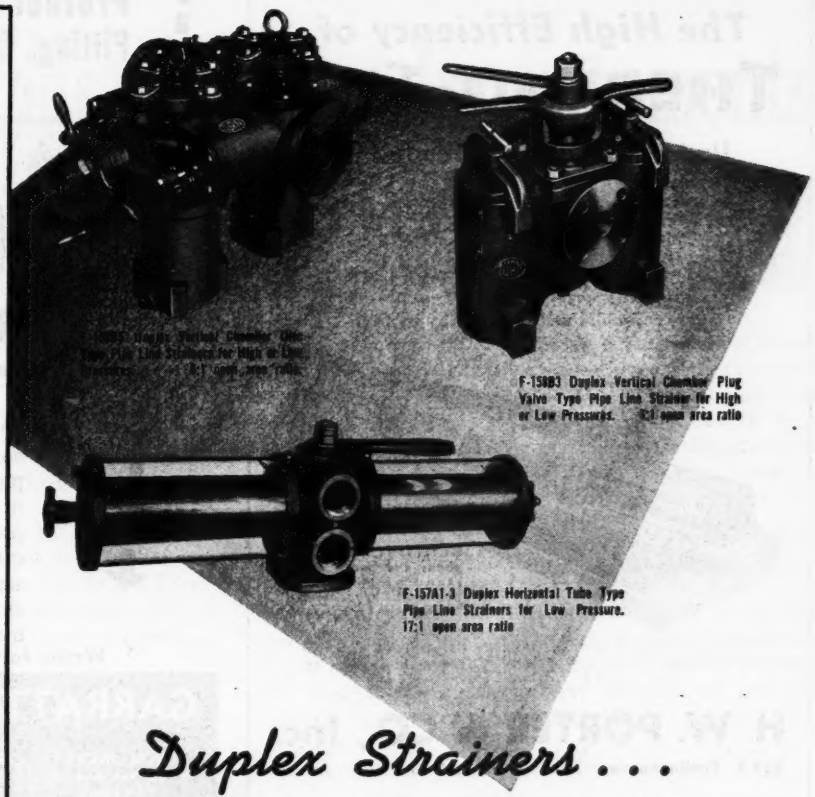
Safety Vents • "Y" Strainers • Discharge Check Valves • Grease & Solids Interceptors • Sinlex Strainers • Duplex Strainers • Fire Line Strainers • Remote Valve Control Assemblies.

And Many Others





F-150B3 Duplex Vertical Chamber Plug Valve Type Pipe Line Strainer for High or Low Pressures. 6:1 open area ratio

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Protects all types of pumps, traps, regulators, aspirators, injectors, control units, valves and other primary equipment. Keeps fluid conveying pipe lines operating freely and efficiently. Avoids clogging, contamination of transported fluids and fouling of equipment. Pressure, suction or gravity flow installations. Air, vapors, liquids and semi-solids services. Intercepts and accumulates precipitates, crystalline aggregates, dirt, sediment, scale, filings and other impurities. Easy-to-operate handwheel reverses valves simultaneously with minimum pressure drop—capacity flow at all positions of wheel. Quick access to basket chamber through removable covers provides easy and complete cleaning of strainer basket. Valves serviced without removing strainer from line. Contact Zurn Research & Development Dept. Our engineers may be able to recommend improvements in your pipe line facilities.

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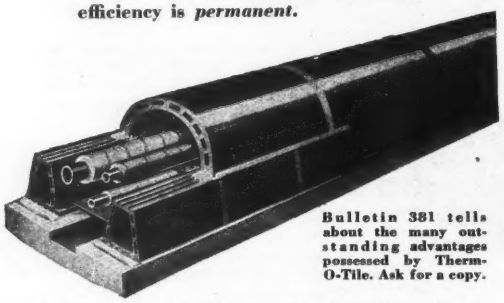

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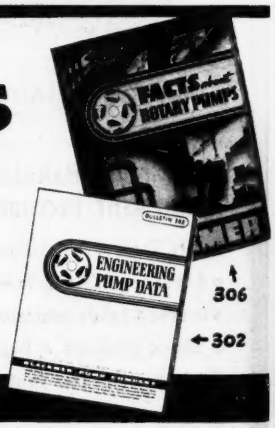

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1198

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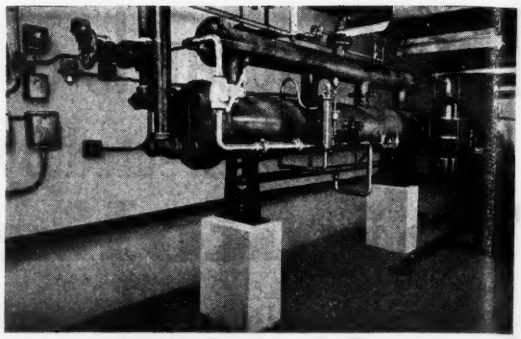

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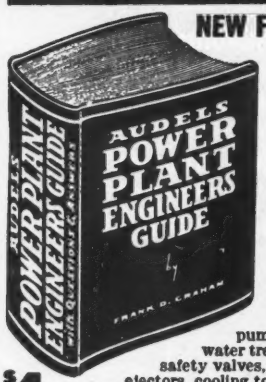

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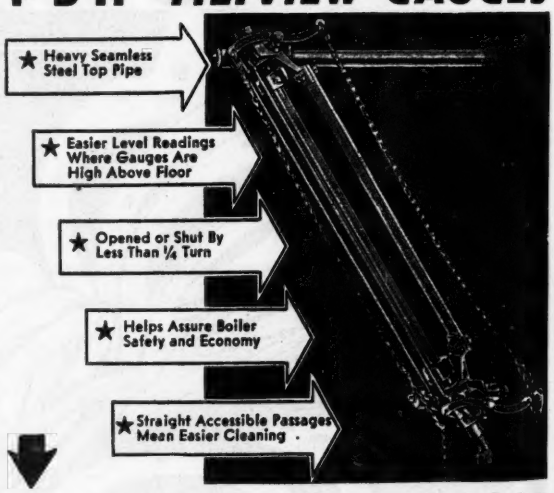
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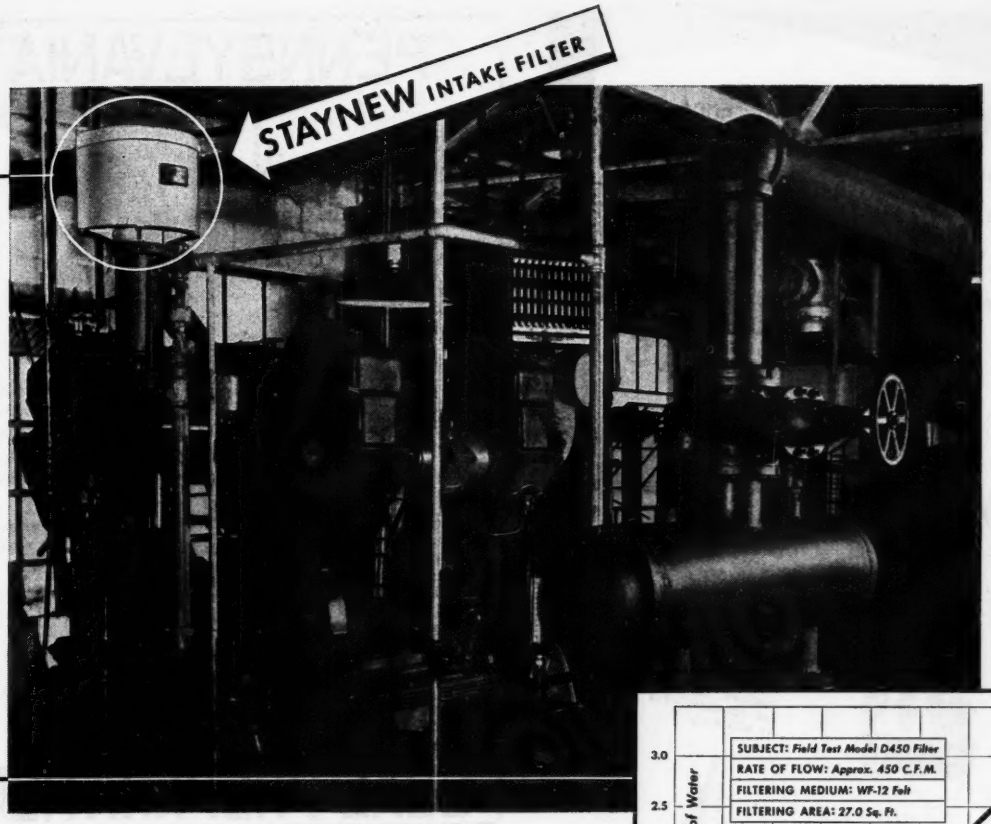


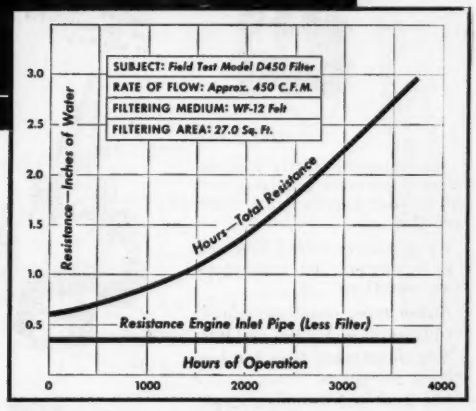
3761 HOURS CONTINUOUS OPERATION WITHOUT ATTENTION

Yet Filter Resistance Is Only 2.73 Inches of Water

This filter, installed on a Diesel-powered compressor, operates under unusually severe conditions. Intake air is heavily loaded with dust and oil; the dust due to the close proximity of a railroad siding where bulk lime, sand, and coal are handled—the oil to two additional Diesel-powered compressors operating in the same room.

Such a case history is not unusual. Reports are frequently received of Staynew Filters operating under less severe conditions for two or more years without attention—with the initially high efficiency rising as dust load increases.

Ease of cleaning as well as infrequency of cleaning is also an important feature, requiring only a few minutes with the specially designed Staynew Cleaning Nozzle.



More and more experienced operators of compressor and engine equipment specify Staynew Intake Filters—not only because of the minimum attention required, but also because these filters:

- ★ **Provide positive protection**
- ★ **Require no pre-coat or filter aid**
- ★ **Are unaffected by extremes of temperature**
- ★ **Permit use of oversize filters (air velocity not critical)**
- ★ **Are ideal for use with carbon ring compressors**

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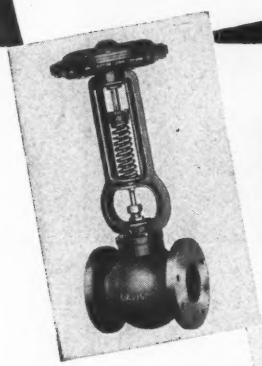
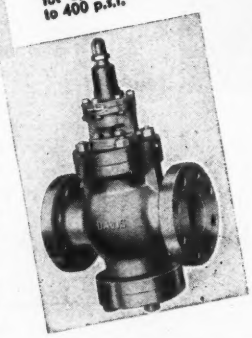


Left: Davis No. 14 direct connected spring loaded regulator for steam, air, gas, water, oil. For pressures to 400 p.s.i. For reduced pressures 0 to 200 lbs.

Below: Davis No. 40 regulator for heavy duty, variable load conditions. Unaffected by high pressure fluctuations. Self-contained, pilot operated. For pressures to 400 p.s.i.



The complete Davis line includes a pressure regulator that will fit your requirements, whatever they are.

Davis *double seated balanced disc* regulators for continuous flow conditions.

Piston type, counterweighted, for pressures of 150 lbs. and less.

The *diaphragm type* for low service pressures.

For dead end service, a *single seated type* maintains pressure reduction irrespective of flow.

Davis *integral auxiliary pilot* controlled regulators for heavy duty, variable load service for either dead end or continuous flow.

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Davis No. 401 regulator. A compact instrument type for accurate, sensitive pressure control. Sizes ½" to 10".

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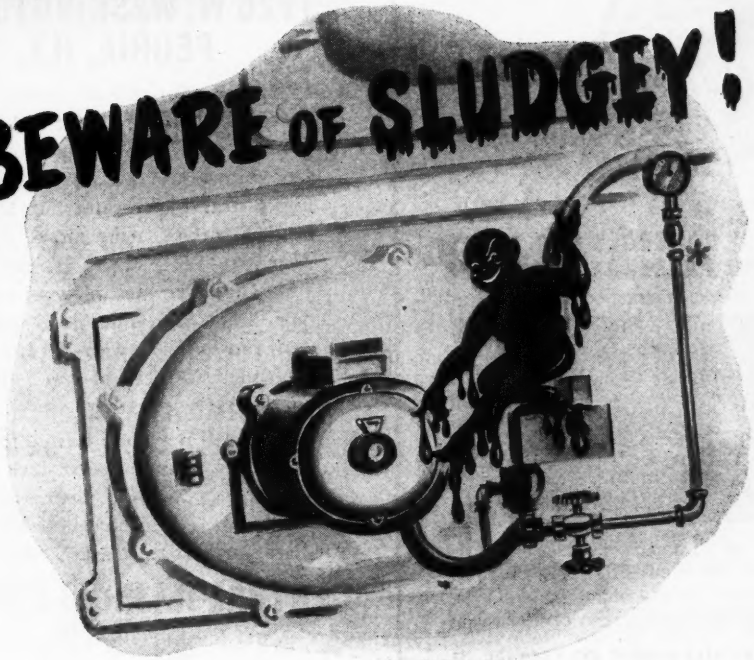

That imp, Sludgey, will certainly get between you and your production if you don't stop him

ALKEN CERTIFIED EVEN-FLO SLUDGE REMOVER prevents the water and other impurities in the oil from settling out as a sludge . . . and will change sludge which has already formed into an emulsion so that it may be burned and its heating value utilized.

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ALKEN CERTIFIED EVEN-FLO SLUDGE REMOVER not only breaks up and disperses the sludge in the oil tanks but also helps keep the pipes leading to the strainers, pre-heaters and nozzles of the burners clean. In other words, it does a COMPLETE job.

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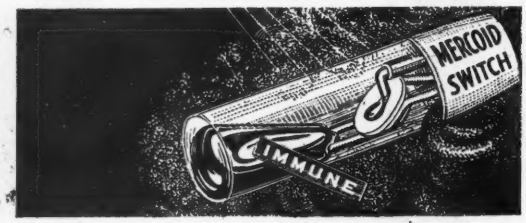
Both controls are available in a number of ranges



Mercoid Controls have an advantage, because they are equipped exclusively with Mercoid DUST-PROOF switches —hence the assurance of better control performance, longer control life and greater economy in control value.

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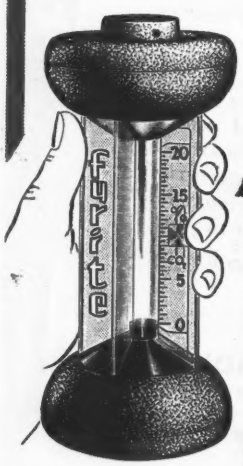

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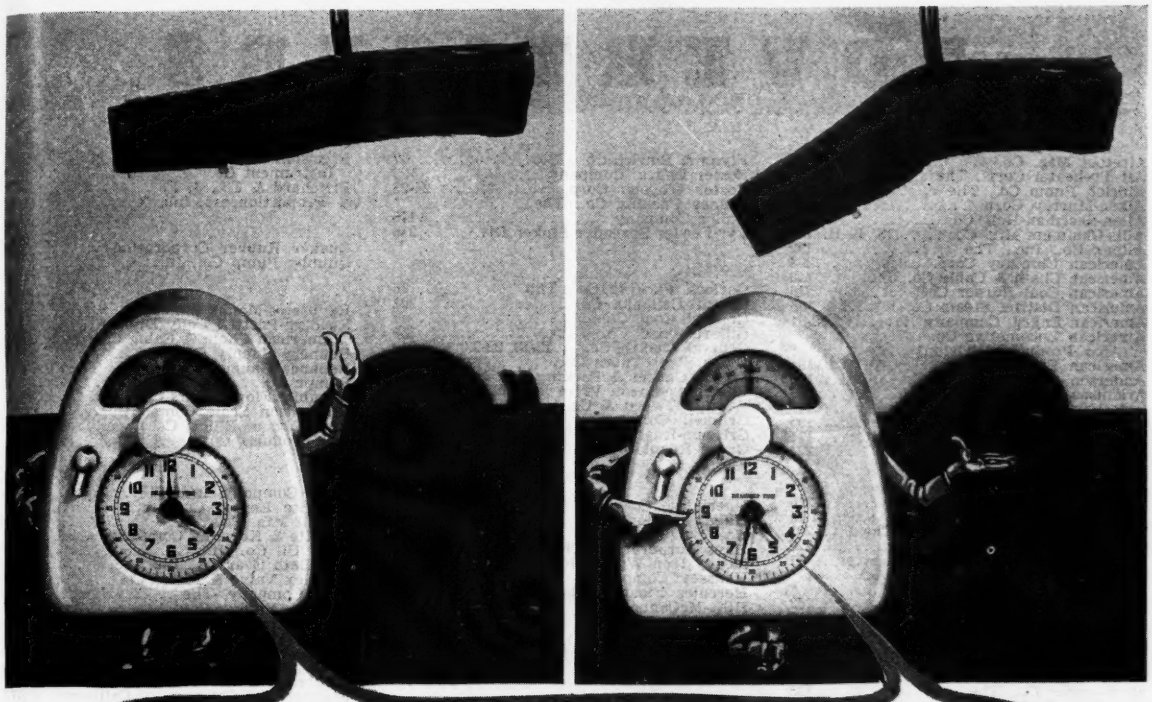

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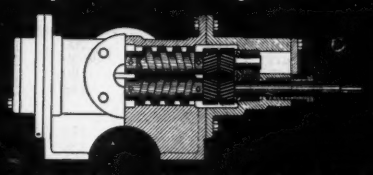

Occasional re-packing can be done while pump is running because there is no pressure on the gland. End to center fluid movement eliminates thrust bearings. Self-centering timing gears prevent side wear of pumping screws resulting from screw contact. No valves -therefore no trouble.

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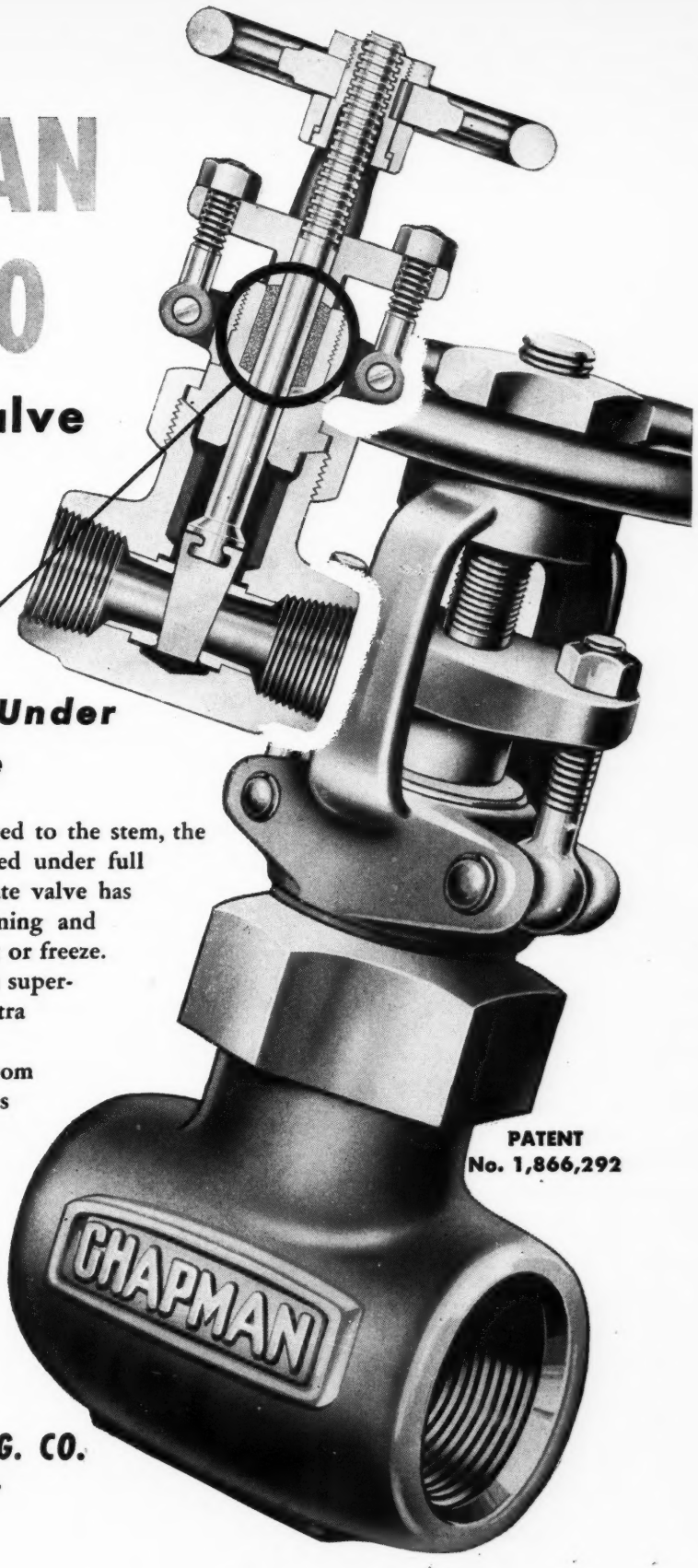
Small Gate Valve



Can Be Repacked Under Full Pressure

Because no pressure is transmitted to the stem, the Chapman List 960 can be repacked under full pressure. This improved small gate valve has quick-acting threads for fast opening and closing—threads that will not stick or freeze. List 960 can also be furnished with super-hardened seats and plugs for extra severe services.

Chapman List 960 is made in sizes from ¼" to 2"—carbon steel for pressures to 800 pounds; alloy steel for pressures to 1000 pounds at 750°F. For higher pressures, specify List 990.

PATENT No. 1,866,292

The CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASS.

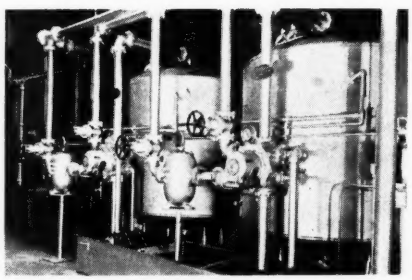
Permutit keeps boilers *clean* — by treating the feedwater before it enters the boilers

In today's heavily burdened power plant, it's easier than ever for impurities in feedwater to cause trouble: scaling and corrosion of boilers and steamlines, slowdowns—possibly even shutdowns.

You can wipe your hands of these troubles with Permutit* conditioned water. Permutit *removes* the impurities in feedwater *before it enters the boilers.*

Manufacturers of water conditioning equipment for over 30 years, Permutit provides *every* process for control of water quality. This includes the Zeo-Karb Water Conditioner (illustrated), Hot and Cold Lime Soda Softeners, Deaerating Heaters, Continuous Blowoff and Demineralizers that deliver a low-cost substitute for evaporated water.

Let Permutit help you prevent boiler scale and corrosion in your steam plant. Write to The Permutit Company, Dep A1, 330 West 42nd Street, New York 18, N. Y. or Permutit Co. of Canada, Ltd., Montreal.



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